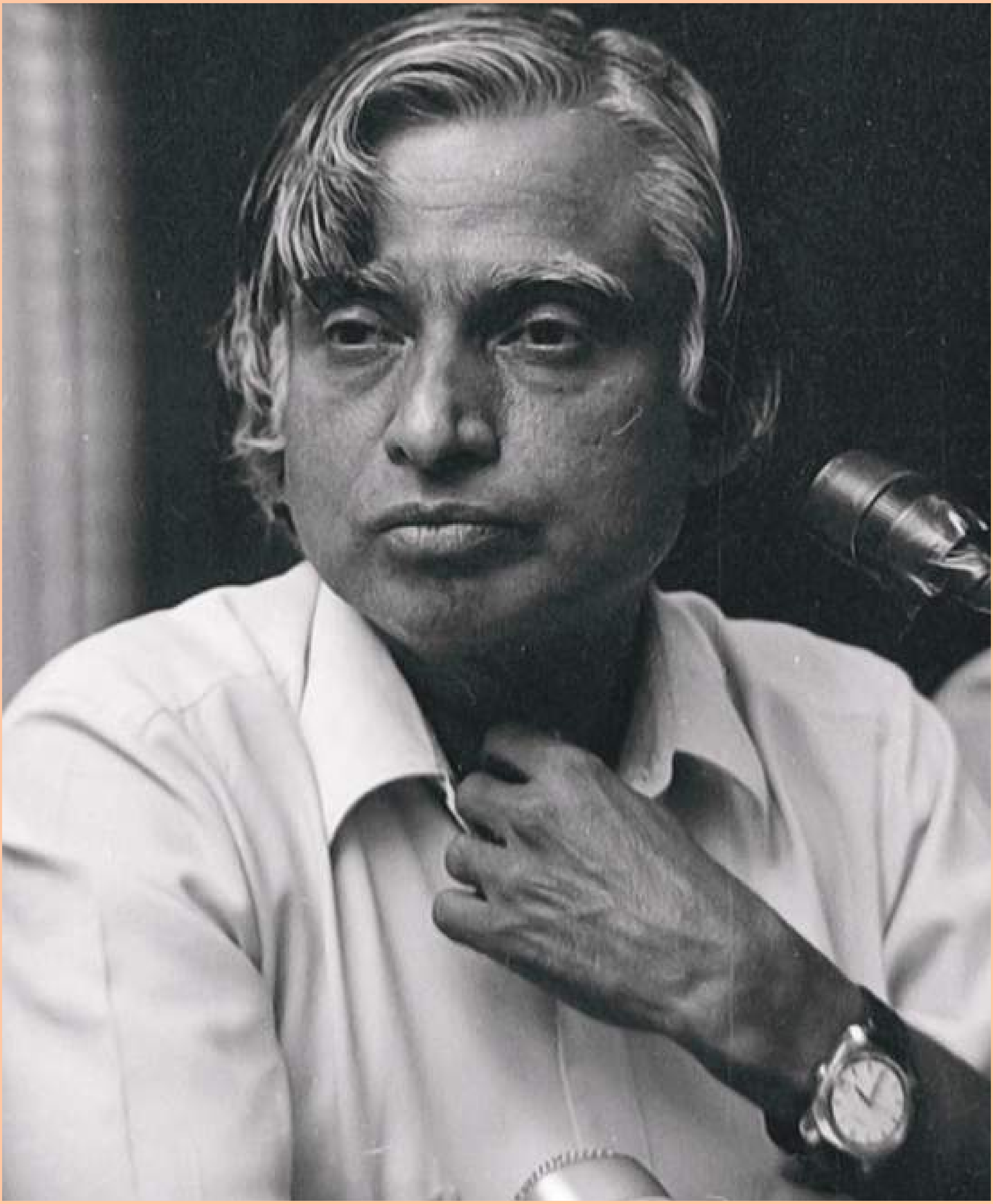
THE GREAT INDIAN SCIENCE STORY

SCIENCE INDIA FORUM UAE

Sastra Prathibha Contest, 2016
Study Material - Sub Juniors

INDEX



in loving memory of

Dr. APJ ABDUL KALAM (15 October 1931 – 27 July 2015)

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LAUNCH READY...

On 24 September 2014 when Malayaan entered the Mars orbit, India became the first country to successfully enter the Mars orbit in maiden attempt. It is owing to the great scientific culture & ancestry and timeless contribution by our great scientists that we were able to achieve this great feat. . Needless to mention the contribution made by the greatest humans world has ever seen as Dr. APJ Abdul Kalam… will remain deeply embedded in the hearts of every aspiring Indian.

India had a glorious history of ancient sciences in the past but we lost them in time due to series of invasions and various other external interventions. India's scientific journey has been a continuous and tremendous one and we can trace it back to thousands of years in the past.

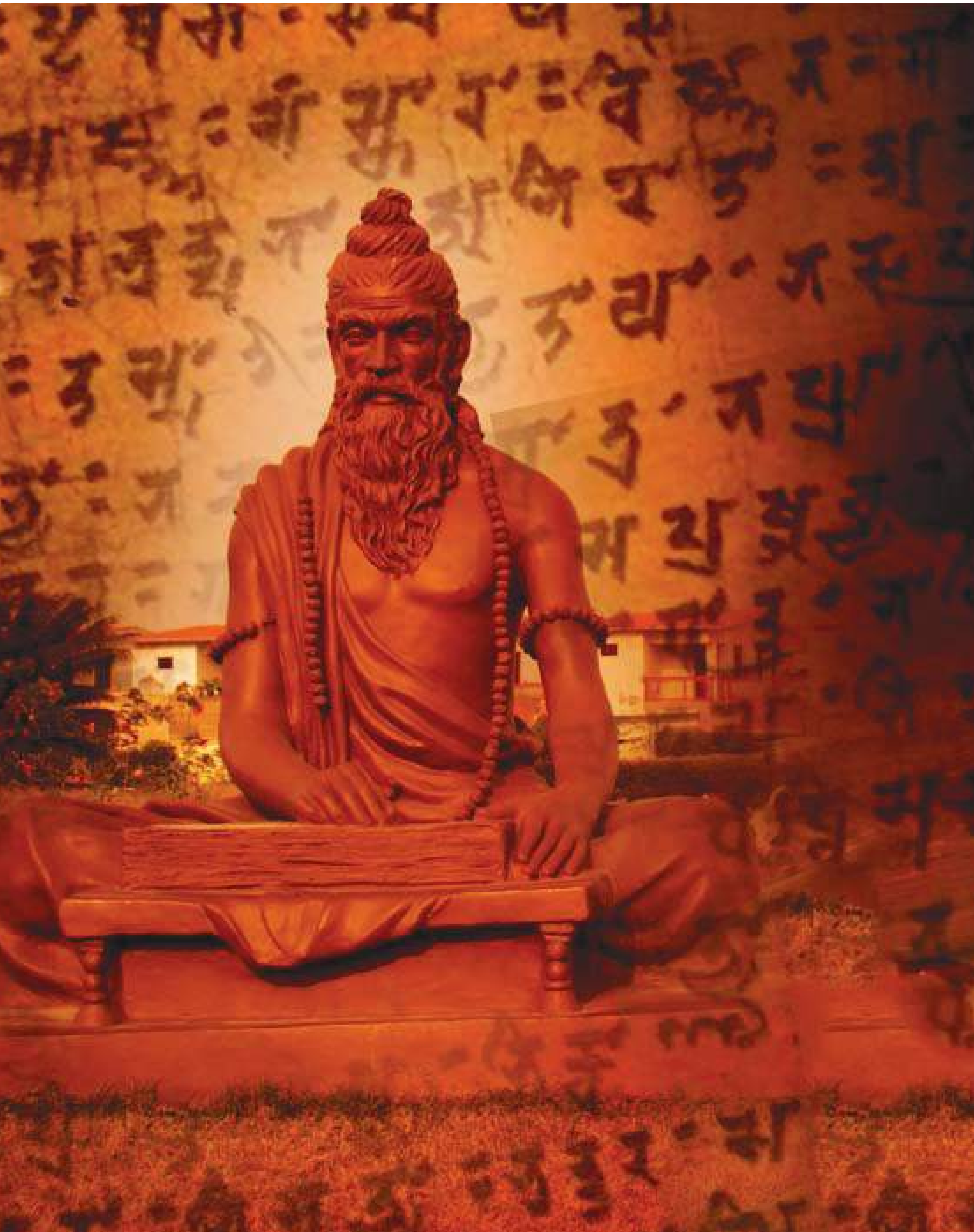
It is pleasantly surprising to note that even today we are able to extract the ancient wisdoms to our advantage as seen in the recent examples like in Chandrayan, during which Aryabhatta's equations of Gravity were used as noted by G. Madhavan Nair, Former Chief of ISRO who said "Even for Chandrayaan, the equation of Aryabhatta was used. Even the (knowledge of) gravitational field... Newton found it some 1500 years later. The knowledge existing (in our scriptures)".

Also recently as witnessed during the dengue outbreak in North India in 2015 when Ayurvedic specialists from across the country were invited to deliver critical care solutions which were available only under Traditional Ayurvedic Medical System. It has been 5300 years since The Indus Valley Civilization, the Science and Technology of Bharat has been on the upswing throughout the centuries.

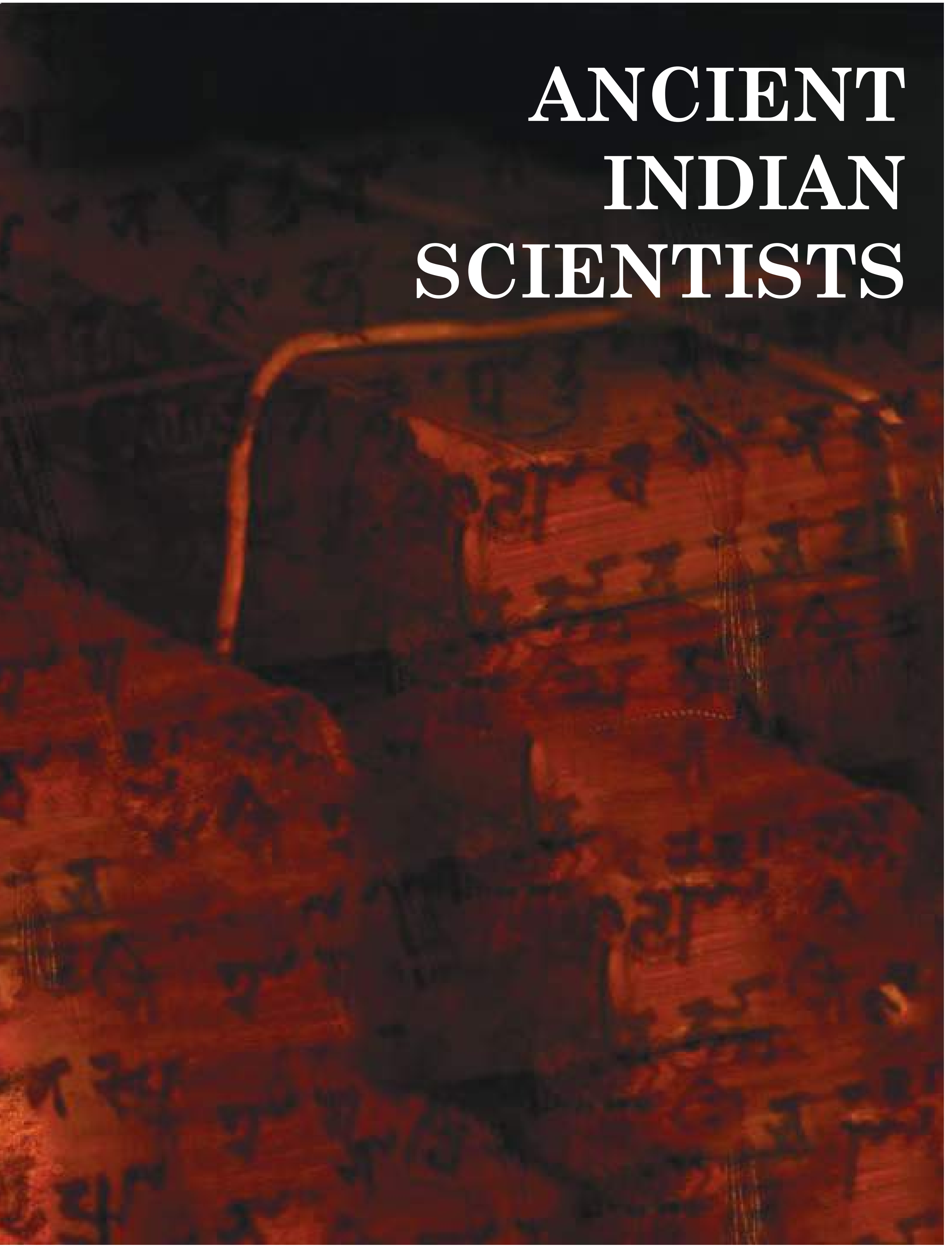
It is nearly impossible even to imagine and understand the vast expanse of scientific competitiveness which India has exhibited throughout ages.

Lets make a humble attempt to briefly contemplate and comprehend the scientific journey of Bharat.

Mangalyaan, India's Mars Mission Taking Off



ANCIENT INDIAN SCIENTISTS



Aryabhatta

feat. mathematics , astronomy, philosophy and our pride..

Statue of **ARYABHATTA**

Statue on the grounds of IUCAA, Pune. As there is no known info. regarding his appearance, any image of Aryabhatta originates from an artist's conception

> "Aryabhatta was a genius and all his theories continue to surprise many mathematicians of the present age

Aryabhatta is the earliest known mathematician-astronomer of India. The birth place of Aryabhatta who lived between circa 476- 550 AD is still a mystery. While many believed he was born in Patliputra in Magadha, the modern-day Patna in the state of Bihar, some others are of the view that he was born in Kerala and lived in Magadha at the time of the Gupta rulers.

His most famous work, Aryabhattiya is a detailed text on mathematics and astronomy. The mathematical part of the Aryabhatiya covers arithmetic, algebra and trigonometry. Aryabhatta was believed to have authored at least three astronomical texts and wrote some free stanzas as well. Aryabhatta was a genius and all his theories continue to surprise many mathematicians of the present age. The Greeks and the Arabs developed some of his works to suit their present demands. He was also the one who created the formula (a + b)2 = a2 + b2+ 2ab.

His other work Arya-siddhanta deals with astronomical calculation and is evident through the writings of Aryabhata's contemporary, Varahamihira and later mathematicians and commentators, including Brahmagupta and Bhaskara I.

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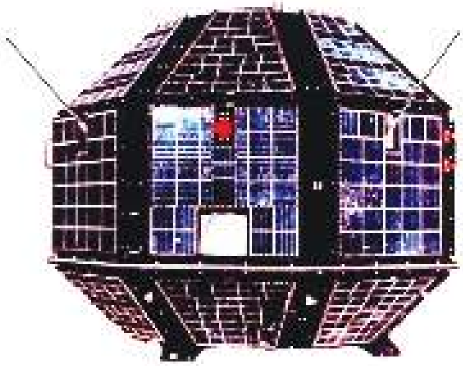
Aryabhatta was aware that the earth rotates on its axis. The earth rotates round the sun and the moon moves round the earth.



SATELLITE **ARYABHATTA**

India's first indigenously built Satellite launched into Space

Aryabhatta was aware that the earth rotates on its axis. The earth rotates round the sun and the moon moves round the earth.

He discovered the positions of the nine planets and related them to their rotation round the sun. He also knew about the eclipse of the sun, moon, day and night, earth contours and the 365 days of the year as the exact length of the year.

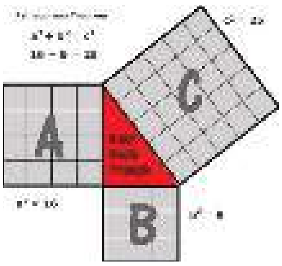
India's first satellite Aryabhatta was named in his honour.

Aryabhatta II

Aryabhaṭa II, the Indian astronomer, is best known for his work entitled Mahasiddhanta or Aryasiddhanta. It has been established indirectly that he lived and worked around the 10th century. In order not to confuse him with the well-known astronomer Aryabhaṭa, who lived in the fifth century, he is known as Aryabhaṭa II or the Younger.

The Mahasiddhanta or Aryasiddhanta is an astronomical compendium based on the orthodox tradition of Smṛtis (passages from Vedic literature). The treatise written in Sanskrit consists of 18 chapters and 625 ślokas (verses). The first 12 chapters' deal with mathematical astronomy. Detailed derivations are presented on topics such as the mean and true longitudes of the planets, eclipses of the Sun and the Moon, the projections of eclipses, the lunar crescent, and the heliacal rising and settings of planets, including some calculations on conjunctions of planets as well as planets with stars. The remaining six chapters of the Mahasiddhanta form a separate section called the Goladhyaya (On the sphere) where topics on geometry, geography, and algebra are discussed with reference to celestial astronomy. He improves upon earlier methods and suggests a shorter procedure. In his work, Aryabhaṭa II also touches upon several arithmetical operations such as the four fundamental operations, operations with zero, extraction of square and cube roots, the rule of three, and fractions. To represent numbers, he adopts the famous kaṭapayAdi system of letter numerals.

Baudhayana



Pythagoras Theorem

It was Baudhāyana who discovered the Pythagoras theorem. Baudhāyana listed Pythagoras theorem in his book called Baudhāyana Śulbasûtra (800 BCE).

BAUDHAYANA
(Born: about 800 BC in India Died: about 800 BC in India)
About Baudhayana it is essentially impossible since nothing is known of him except that he was the author of one of the earliest Sulbasutras. We do not know his dates accurately enough to even guess at a life span for him, which is why we have given the same approximate Birth Year as Death Year.

He was neither a Mathematician in the sense that we would understand it today, nor a scribe who simply copied manuscripts like *Ahmes*. He would certainly have been a man of very considerable learning but probably not interested in Mathematics for its own sake, merely interested in using it for Religious purposes. Undoubtedly he wrote the Sulbasutra to provide rules for Religious rites and it would appear an almost certainty that Baudhayana himself would be a Vedic Priest.

The Mathematics given in the Sulbasutras is there to enable the accurate Construction of altars needed for sacrifices. It is clear from the writing that Baudhayana, as well as being a Priest, must have been a skilled craftsman. He must have been himself skilled in the Practical use of the Mathematics he described as a Craftsman who himself constructed sacrificial altars of the highest quality.

The Sulbasutras are discussed in detail in the article Indian Sulbasutras. Below we give one or two details of Baudhayana's Sulbasutra, which contained three chapters, which is the oldest which we possess and, it would be fair to say, one of the two most important.

Several values of π occur in Baudhayana's Sulbasutra since when giving different constructions Baudhayana uses different approximations for constructing circular shapes.

Pythagorean theorem also was first presented in 800 BCE by Baudhayana.

Bhaskara I

BHASKARA I (Born: about 600 in Saurastra India Died: about 680 in Asmaka, India)
We have very little information about Bhaskara I's life except what can be deduced from his writings. Shukla deduces from the fact that Bhaskara I often refers to the Asmakatantra instead of the Aryabhatiya that he must have been working in a school of mathematicians in Asmaka which was probably in the Nizamabad District of Andhra Pradesh. If this is correct, and it does seem quite likely, then the school in Asmaka would have been a collection of scholars who were followers of Aryabhata I and of course this fits in well with the fact that Bhaskara I himself was certainly a follower of Aryabhata I.

There are other references to Places in India in Bhaskara's writings. For example he mentions Valabhi (today Vala), the capital of the Maitraka dynasty in the 7th century, and Sivarajapura, which were both in Saurastra which today is the Gujarat state of India on the west coast of the continent. Also mentioned are Bharuch (or Broach) in southern Gujarat and Thanesar in the eastern Punjab which was ruled by Harsa for 41 years from 606.

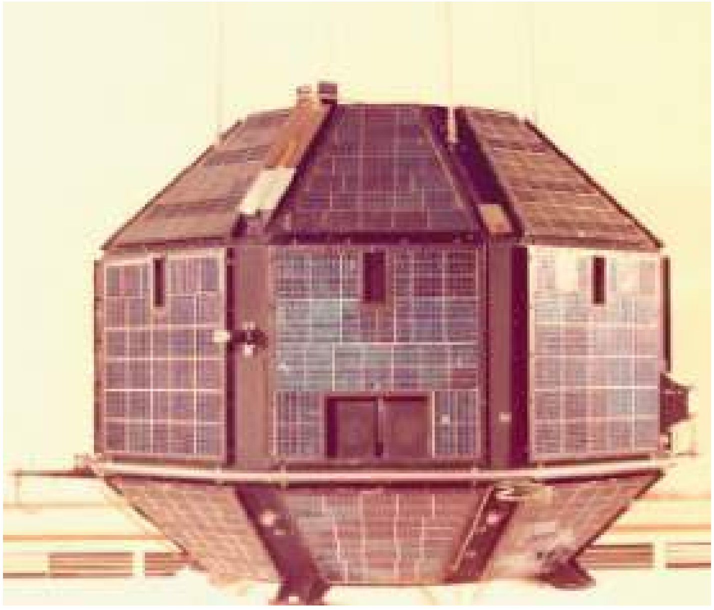
Bhaskara I was an Author of two treatises and commentaries to the work of Aryabhata I. His works are the Mahabhaskariya, the Laghubhaskariya and the Aryabhatiyabhas ya. The Mahabhaskariya is an eight chapter work on Indian Mathematical astronomy and includes topics which were fairly standard for such works at this time. It discusses topics such as: the longitudes of the planets; conjunctions of the planets with each other and with bright stars; eclipses of the sun and the moon; risings and settings; and the lunar crescent. Bhaskara I included in his treatise the Mahabhaskariya three verses which give an Approximation to the trigonometric sine function by means of a rational fraction. These occur in Chapter 7 of the work. The formula which Bhaskara gives is amazingly accurate and use of the formula leads to a maximum error of less than one percent.

In 629 Bhaskara I wrote a commentary, the Aryabhatiyabhasya, on the Aryabhatiya by Aryabhata I. The Aryabhatiya contains 33 verses dealing with mathematics, the remainder of the work being concerned with Mathematical astronomy. The commentary by Bhaskara I is only on the 33 verses of mathematics.

"Mahabhaskariya comprises of eight chapters dealing with mathematical astronomy. The formula which Bhaskara gives is amazingly accurate and use of the formula leads to a maximum error of less than one percent.

Sine x = 16x (ð – x) / [5 ð2 – 4x (ð – x)]

Bhaskara II



Bhaskara-1 was the first experimental remote sensing satellite built by India, named after Bhaskaracharya.

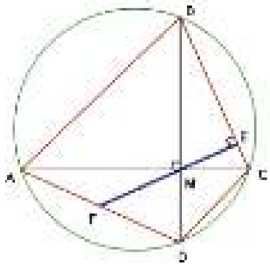
Bhaskara II, also known as Bhaskaracharya, was born in 1114 AD near Vijjadavida or the modern-day Bijapur in the state of Karnataka.

Born to a family of scholars, he learnt mathematics from his astrologer father Mahesvara.

A leading mathematician of 12th century, he wrote his first work on the systematic use of the decimal number system. He also headed the astronomical observatory at Ujjain, the leading mathematical centre of ancient India.

His main work Siddhanta Sjhiromani, which has four parts, namely Lilavati, Bijaganita Grahaganita and Goladhaya and deals with arithmetic, algebra, mathematics of the planets, and spheres, respectively. Bhaskara is particularly known for the discovery of the principles of differential calculus and its application to astronomical problems and computations.

While Newton and Leibniz have been credited with differential and integral calculus, there is strong evidence to suggest that Bhaskara was a pioneer in some of the principles of differential calculus. He was perhaps the first to conceive the differential coefficient and differential calculus.



AF = FD

Brahmagupta

Brahmagupta (598–c.670 CE),
was an Indian mathematician and astronomer who wrote two works on Mathematics and Astronomy: The Brāhmasphuṭasiddhānta (Extensive Treatise of Brahma) (628), a theoretical treatise, and the Khaṇḍakhādyaka, a more practical text. There are reasons to believe that Brahmagupta originated from Bhinmal.
Brahmagupta was the first to give rules to compute with zero.

It seems likely that Brahmagupta's works, especially his most famous text, the "Brahmasphutasiddhanta", were brought by the 8th Century Abbasid caliph Al-Mansur to his newly founded centre of learning at Baghdad on the banks of the Tigris, providing an important link between Indian mathematics and astronomy and the nascent upsurge in science and mathematics in the Islamic world.

Brahmagupta's genius, though, came in his treatment of the concept of (then relatively new) the number zero. Although often also attributed to the 7th Century Indian mathematician Bhaskara I, his "Brahmasphutasiddhanta " is probably the earliest known text to treat zero as a number in its own right, rather than as simply a placeholder digit as was done by the Babylonians, or as a symbol for a lack of quantity as was done by theGreeks and Romans.

Brahmagupta's view of numbers as abstract entities, rather than just for counting and measuring, allowed him

to make yet another huge conceptual leap which would have profound consequence for future mathematics. Previously, the sum 3 - 4, for example, was considered to be either meaningless or, at best, just zero. Brahmagupta, however, realized that there could be such a thing as a negative number, which he referred to as "debt" as a opposed to "property". He expounded on the rules for dealing with negative numbers (e.g. a negative times a negative is a positive, a negative times a positive is a negative, etc)

Brahmagupta developed the earliest known methods for computing with zero.

In addition to his work on solutions to general linear equations and quadratic equations, Brahmagupta went yet further by considering systems of simultaneous equations, and solving quadratic equations with two unknowns, something which was not even considered in the West until a thousand years later, when Fermat was considering similar problems in 1657.

Chanakya

> *A man is great by deeds, not by birth.*

One of the greatest figures of wisdom and knowledge in the Indian history is Chanakya. He is estimated to have lived from 350 - 283 B.C. Chanakya is touted as the "Pioneer Economist of India". Chanakya was the adviser and Prime Minister of Emperor Chandragupta. Chanakya was a professor at the University of Takshila (located in present day Pakistan) and was an expert in commerce, warfare, economics, etc. His famous works include Chanakya Neeti, Arthashastra and Neetishastra. Read this biography of Kautilya that covers his interesting life history.

Chanakya is also known by the name of Kautilya and Vishnugupta as is mentioned in his text. His famous work called Arthashastra is a classic example of statecraft and politics and is read in Europe even today. It

basically consists of the principles of politics and how the state works.

The diplomatic enclave in New Delhi is named Chanakyapuri in honour of Chanakya. Institutes named after him include Training Ship Chanakya, Chanakya National Law University and Chanakya Institute of Public Leadership.

A recovered manuscript of Arthashastra.

Charaka

Charak, sometimes spelled Charaka,
was one of the principal contributors to the ancient art and science ofAyurveda, a system of medicine and lifestyle developed in Ancient India. He is sometimes dated to c. 800 BC as he worked on older treatise by Purnvasu Atreya (c.1000 BC) and Agnivesha Agnivesa, of whose work, the Agnivesha Tantra, was the basis of his Charaka Samhita Charaka is also referred to as the Father of Medicine.
The term Charaka is a label said to apply to "wandering scholars" or "wandering physicians". According to Charaka's translations, health and disease are not predetermined and life may be prolonged by human effort and attention to lifestyle. As per Indian heritage and science of Ayurvedic system, prevention of all types of diseases have a more prominent place than treatment, including restructuring of lifestyle to align with the course of nature and four seasons, which will guarantee complete wellness. He seems to have been an early proponent of prevention is better than cure doctrine.

“ *A physician who fails to enter the body of a patient with the lamp of knowledge and understanding can never treat diseases. He should first study all the factors, including environment, which influence a patient's disease, and then prescribe treatment. It is more important to prevent the occurrence of disease than to seek a cure.*

Kanada

atomic theory, condensed..

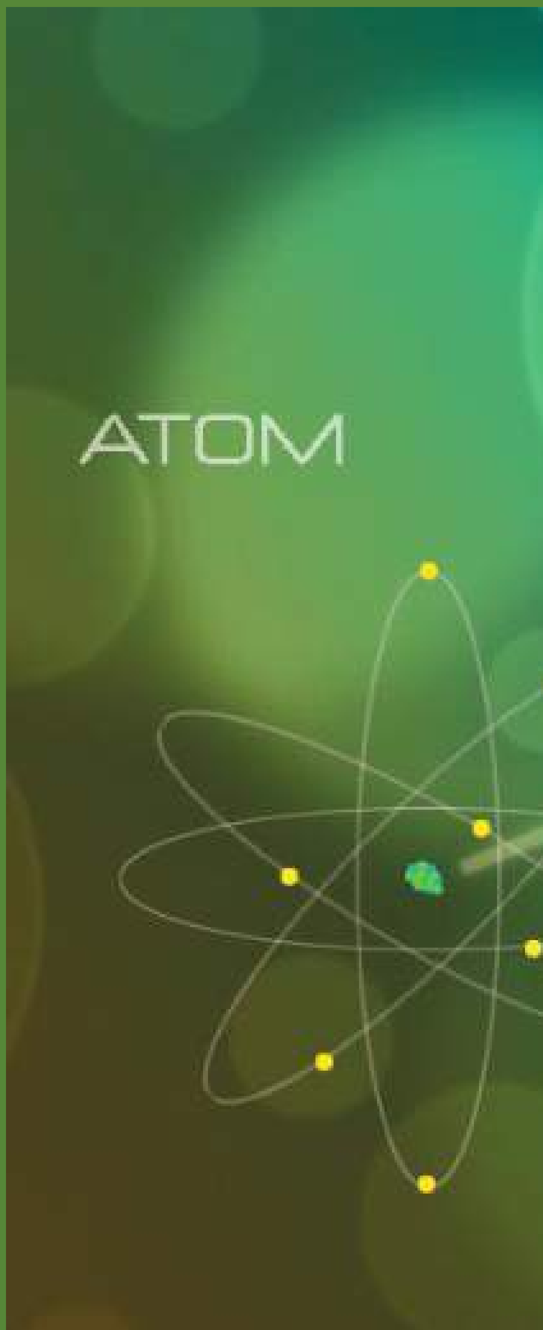
What is the relationship between man, the universe and their creator? This question has always intrigued philosophers and thinkers. Between 600 B.C. and 200 A.D. there were several attempts by Indian philosophers to find an answer to the question.

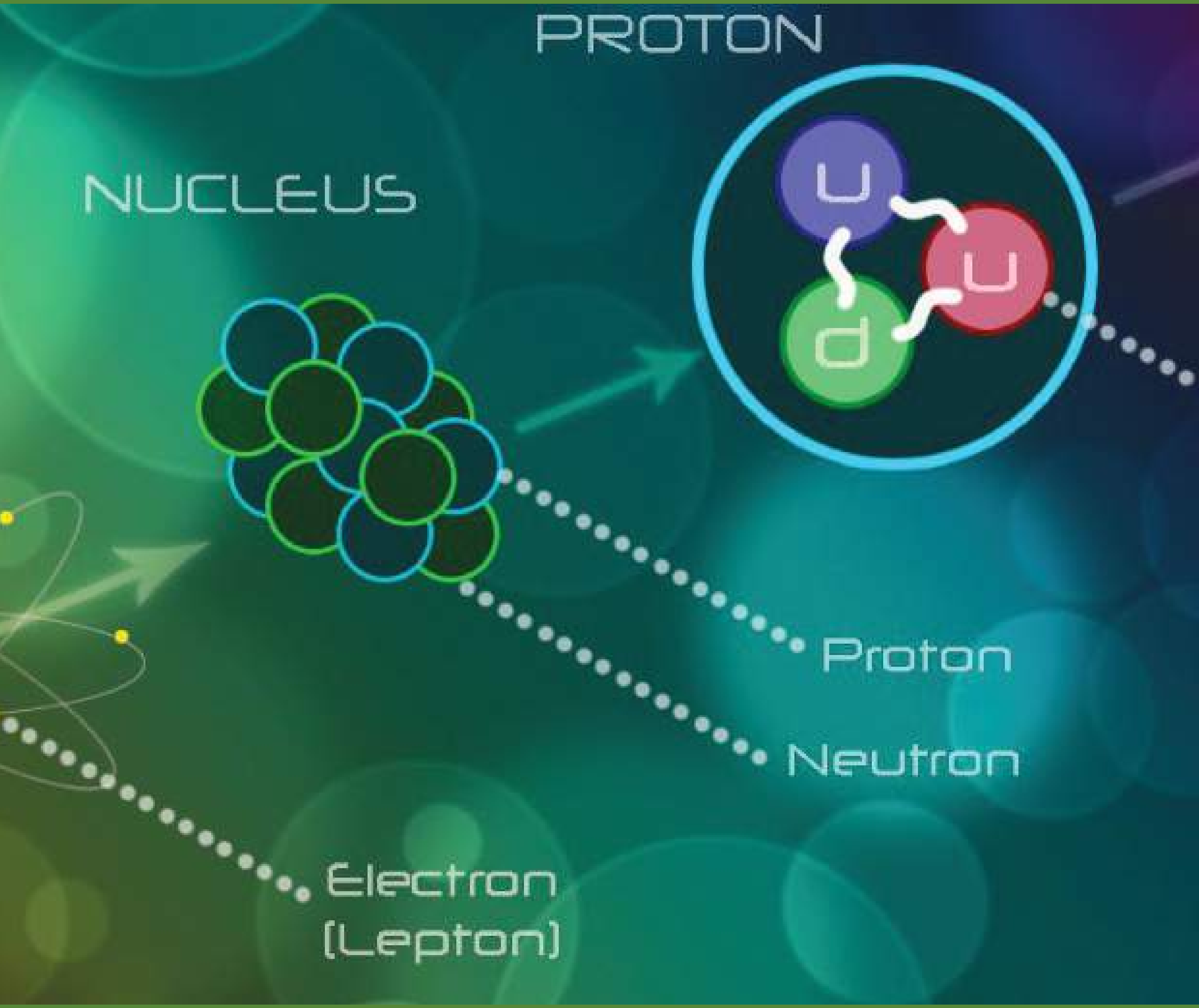
One of these was Kanada, who, in about 600 B.C. at Prabhasa propounded the Vaisesikasutra (Peculiarity Aphorisms). Today, we realize that these sutras are a blend of science, philosophy and religion. Their essence is the atomic theory of matter. If Kanada's sutras are analysed, one would find that his atomic theory was far more advanced than those forwarded later by the Greek philosophers, Leucippus and Democritus. In fact, he gave the name paramanu (atom) to an indivisible entity of matter.

According to Kanada, everything is made up of paramanu. When matter is divided, then further divided, till no further division is possible, the remaining indivisible entity is called paramanu. This entity does not exist in a free state, nor can it be sensed through any human organ. It is eternal and indestructible.

Kanada added-and it is here that he took a lead over other philosophers-that there are a variety of paramanu as different as the different classes of substances then believed to exist, namely, earth, water, air and fire. Each paramanu has a peculiar property which is the same as the class of substance it belongs to. It is only because of this peculiarity of paramanu that the theory was called Vaisesikasutras.

If two paramanu belonging to one class of substance combined, a dwinuka (binary molecule) was produced, which had properties similar to those of the two original paramanu.





"Vaisesika philosophy . . . seeks to escape from *the phenomenological world by wrapping the whole realm of external existence up into a neat explanatory parcel, atomism, so that the intellect need no longer trouble itself with such problems and is thus free to continue on to the higher spheres of thought which are its more appropriate concern."*

Katyayana

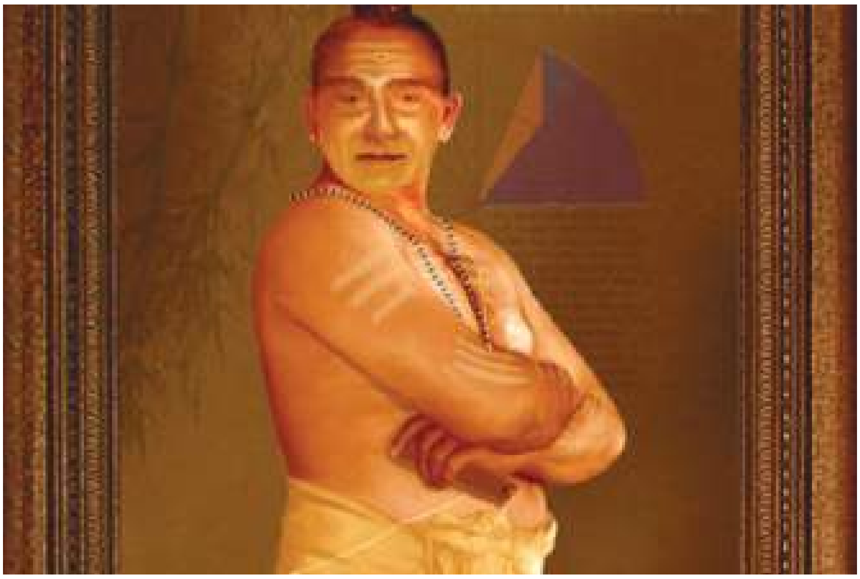
Kātyāyana (c. 3rd century BC) was a Sanskrit grammarian, mathematician and Vedic priest who lived in ancient India.
He is known for two works:

- The Varttika, an elaboration on Pāṇini grammar. Along with the Mahābhāsya of Patañjali, this text became a core part of the Vyākarana (grammar) canon. This was one of the six Vedangas, and constituted compulsory education for students in the following twelve centuries.
- He also composed one of the later Sulba Sutras, a series of nine texts on the geometry of altar constructions, dealing with rectangles, right-sided triangles, rhombuses, etc

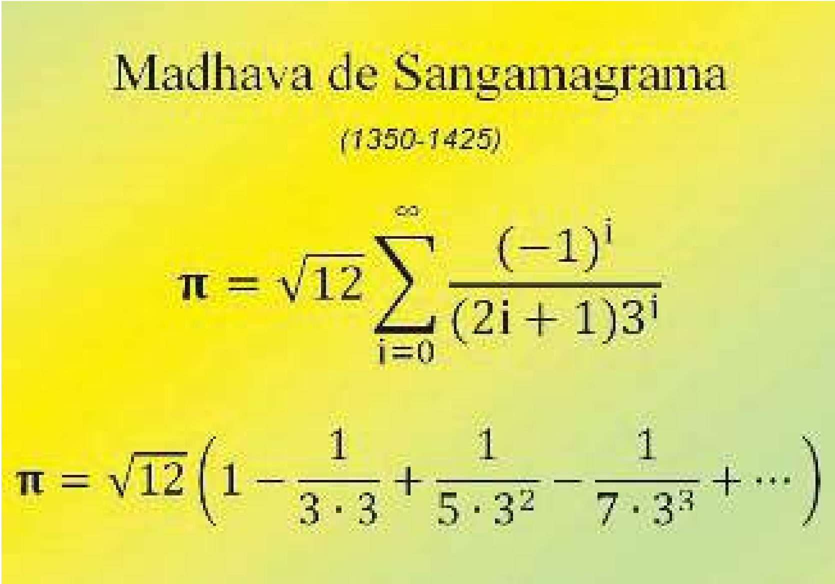
Kātyāyana's views on the sentence-meaning connection tended towards naturalism. Kātyāyana believed, that the word-meaning relationship was not a result of human convention. For Kātyāyana, word-meaning relations were siddha, given to us, eternal. Though the object a word is referring to is non-eternal, the substance of its meaning, like a lump of gold used to make different ornaments, remains undistorted, and is therefore permanent.

In the tradition of scholars like Pingala, Kātyāyana was also interested in mathematics. Here his text on the sulvasutras dealt with geometry, and extended the treatment of the Pythagorean theorem as first presented in 800 BCE by Baudhayana.
Kātyāyana belonged to the Aindra school of grammarians and may have lived towards the Northwest of the Indian subcontinent

Madhava



Madhava sometimes called the greatest mathematician-astronomer of medieval India. He came from the town of Sangamagrama in Kerala, near the southern tip of India, and founded the Kerala School of Astronomy and Mathematics in the late 14th Century.
Although almost all of Madhava's original work is lost, he is referred to in the work of later Kerala mathematicians as the source for several infinite series expansions (including the sine, cosine, tangent



and arctangent functions and the value of π), representing the first steps from the traditional finite processes of algebra to considerations of the infinite, with its implications for the future development of calculus and mathematical analysis.
Unlike most previous cultures, which had been rather nervous about the concept of infinity, Madhava was more than happy to play around with infinity, particularly infinite series. He showed how, although one can be approximated by adding a half plus a quarter plus an eighth plus a sixteenth, etc, (as even the ancient Egyptians and Greeks had known), the exact total of one can only be achieved by adding up infinitely many fractions. But Madhava went further and linked the idea of an infinite series with geometry and trigonometry. He realized that, by successively adding and subtracting different odd number fractions to infinity, he could home in on an exact formula for π (this was two centuries before Leibniz was to come to the same conclusion in Europe).
Through his application of this series, Madhava obtained a value for π correct to an astonishing 13 decimal places.
He also gave estimates of the error term or correction term, implying that he quite understood the limit nature of the infinite series. Some historians have suggested that Madhava's work, through the writings of the Kerala School, may have been transmitted to Europe via Jesuit missionaries and traders who were active around the ancient port of Cochin (Kochi) at the time, and may have had an influence on later European developments in calculus.
Madhava series is any one of the series in a collection of infinite series expressions all of which are believed to have been discovered by Madhava, the founder of the Kerala school of astronomy and mathematics. These expressions are the infinite power series expansions of the trigonometric sine, cosine and arctangent functions, and the special case of the power series expansion of the arctangent function yielding a formula for computing π.

The power series expansion of the arctangent function is sometimes called Madhava–Gregory seriesor Gregory–Madhava series.

Manava

Recovered manuscript of Manava's Sulbasutra

Manava (ca. 750 BC – 690 BC) is an author of the Indian geometric text of Sulba Sutras. The Manava Sulbasutra is not the oldest (the one by Baudhayana is older), nor is it one of the most important, there being at least three Sulbasutras which are considered more important. Historians place his lifetime at around 750 BC. Manava would have not have been a mathematician in the sense that we would understand it today. Nor was he a scribe who simply copied manuscripts like Ahmes. He would certainly have been a man of very considerable learning but probably not interested in mathematics for its own sake, merely interested in using it for religious purposes. Undoubtedly he wrote the Sulbasutra to provide rules for religious rites and it would appear almost a certainty that Manava himself would be a Vedic priest. The mathematics given in the Sulbasutras is there to enable accurate construction of altars needed for sacrifices. It is clear from the writing that Manava, as well as being a priest, must have been a skilled craftsman.

Nagarjuna

Nāgārjuna (150 – 250 AD) is widely considered one of the most important Buddhist philosophers after Gautama Buddha. Along with his disciple Āryadeva, he is considered to be the founder of the Madhyamaka school of Mahāyāna Buddhism.

Relativity

Nagarjuna also taught the idea of relativity in Ratnāvalī.

Nagarjuna as Ayurvedic physician

According to Frank John Ninivaggi, Nagarjuna was also a practitioner of Ayurveda. First described in the Sanskrit medical treatise Sushruta Samhita, of which he was the compiler of the redaction, many of his conceptualisations, such s his descriptions of the circulatory system and blood tissue (described as rakta dhātu) and his pioneering work on the therapeutic value of specially treated minerals knowns as bhasmas, which earned him the title of the "father of iatrochemistry

Patanjali

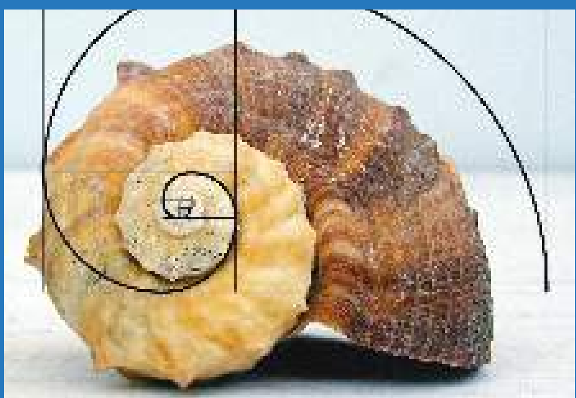
Maharishi Patanjali is the compiler of the Yoga Sutras, along with being the author of a commentary on Panini's Ashtadhyayi, known as Mahabhasya.
The life history of Patanjali is full of legends and contradictions. There are no authentic records regarding his birth. As per one legend, he fell (pata) into the hands (anjali) of a woman, thus giving him the name Patanjali.

Patanjali Yoga Sutras
It is said that once, while watching a dance by Lord Shiva, Adi Shesha found it unbearable to support the weight of Lord Vishnu. Amazed at this, he asked Lord Vishnu the reason for the same. Lord Vishnu said that this was because of his harmony with Lord Shiva's energy state, owing to the practice of Yoga. Realizing the value and benefits of Yoga, Adi Shesha decided to be born amongst humans as 'Patanjali', to teach them the great art.

Yoga Sutras are considered to serve as the basis of the yogic techniques. Maharishi Patanjali, "The Father of Yoga", compiled 195 sutras, which serve as a framework for integrating Yoga into the daily routine and leading an ethical life. The exact date of the compilation of the Yoga Sutras is not known. However, it is believed that they were written somewhere around 200 BC. The core of Patanjali's teachings lies in the eightfold path of yoga. The path shows the way to live a better life through yoga.

Pingala

Pingala is the traditional name of the author of the Chandaḥśāstra (also Chandaḥsūtra), the earliest known Sanskrit treatise on prosody.
Little is known about Piṅgala himself. In later Indian literary tradition, he is variously identified either as the younger brother of Pāṇini (4th century BC), or as Patañjali, the author of the Mahabhashya (2nd century BC).
The Chandaḥśāstra is a work of eight chapters in the late Sūtra style, not fully comprehensible without a commentary. It has been dated to either the final centuries BC or the early centuries AD, at the transition between Vedic meter and the classical meter of the Sanskrit epics. This would place it close to the beginning of the Common Era, likely post-dating Mauryan times. The 10th century mathematician Halayudha wrote a commentary on the Chandaḥśāstra and expanded it.



The Fibonacci Sequence was described by Pingala ~1200 years before Fibonacci wrote of it.

The Chandaḥśāstra presents the first known description of a binary numeral system in connection with the systematic enumeration of meters with fixed patterns of short and long syllables.

Pingala's work also contains the Fibonacci numbers, called mātrāmeru.
Use of zero is sometimes mistakenly ascribed to Pingala due to his discussion of binary numbers, usually represented using 0 and 1 in modern discussion, while Pingala used light (laghu) and heavy (guru) syllables. Positional use of zero dates from c. the 7th century (Brahmagupta) and would have been known to Halāyudha but not to Pingala.

Sushrutha

An ancient Indian surgeon dating back to almost 2500 years ago, Sushruta made numerous contributions to the field of surgery. Sushruta is regarded as the father of surgery. He authored the book Sushruta Samhita in which he described over 300 surgical procedures, 120 surgical instruments and classified human surgery in eight categories. He lived, taught and practised his art on the banks of the Ganges which can now be called Varanasi in North India.

Some of his contributions include surgical demonstration of techniques of making incisions, probing, extraction of foreign bodies, alkali and thermal cauterization, tooth extraction, excisions, etc. He also described removal of the prostate gland, urethral, hernia surgery, caesarian section. He classified details of the six types of dislocations, twelve varieties of fractures and classification of the bones and their reaction to the injuries. He has written about 76 signs of various eye diseases, symptoms, prognosis, medical/ surgical interventions and cataract surgery. There is also description of method of stitching the intestines by using ant-heads as stitching material. He even introduced wine to minimize the pain of surgical incisions.

Vaghabhata

Vāgbhata is one of the most influential classical writers of ayurveda. Several works are associated with his name as author, principally the Ashtāṅgasaṅgraha and the Ashtāngahridayasaṃhitā . Both works make frequent reference to the earlier classical works, the Charaka Samhita and the Sushruta Samhita. Vāgbhata is said, in the closing verses of the Ashtānga sangraha, to have lived in Sind (today in Pakistan), and to have been the son of Simhagupta and pupil of Avalokita. He was a Buddhist, as is shown by his explicit praise for the Buddha by name at the start of the Ashtāngasangraha, and his praise of the Buddha under the title "Unprecedented Teacher" in the opening verse of the Ashtānga hridayasamhitā. His work contains syncretic elements.

As per modern scholarship he was an ethnic Kashmiri, and for instance the German Indologist Claus Vogel said "...judging by the fact that he expressly defines Andhra and Dravida as the names of two southern peoples or kingdoms and repeatedly mentions Kashmirian terms for particular plants, he is likely to have been a Northerner and a native of Kashmir..."

Vagbhata was a disciple of Charaka. Both of his books were originally written in Sanskrit with 7000 sutra. According to Vagbhata, 85% of diseases can be cured without a doctor; only 15% of diseases require a doctor.

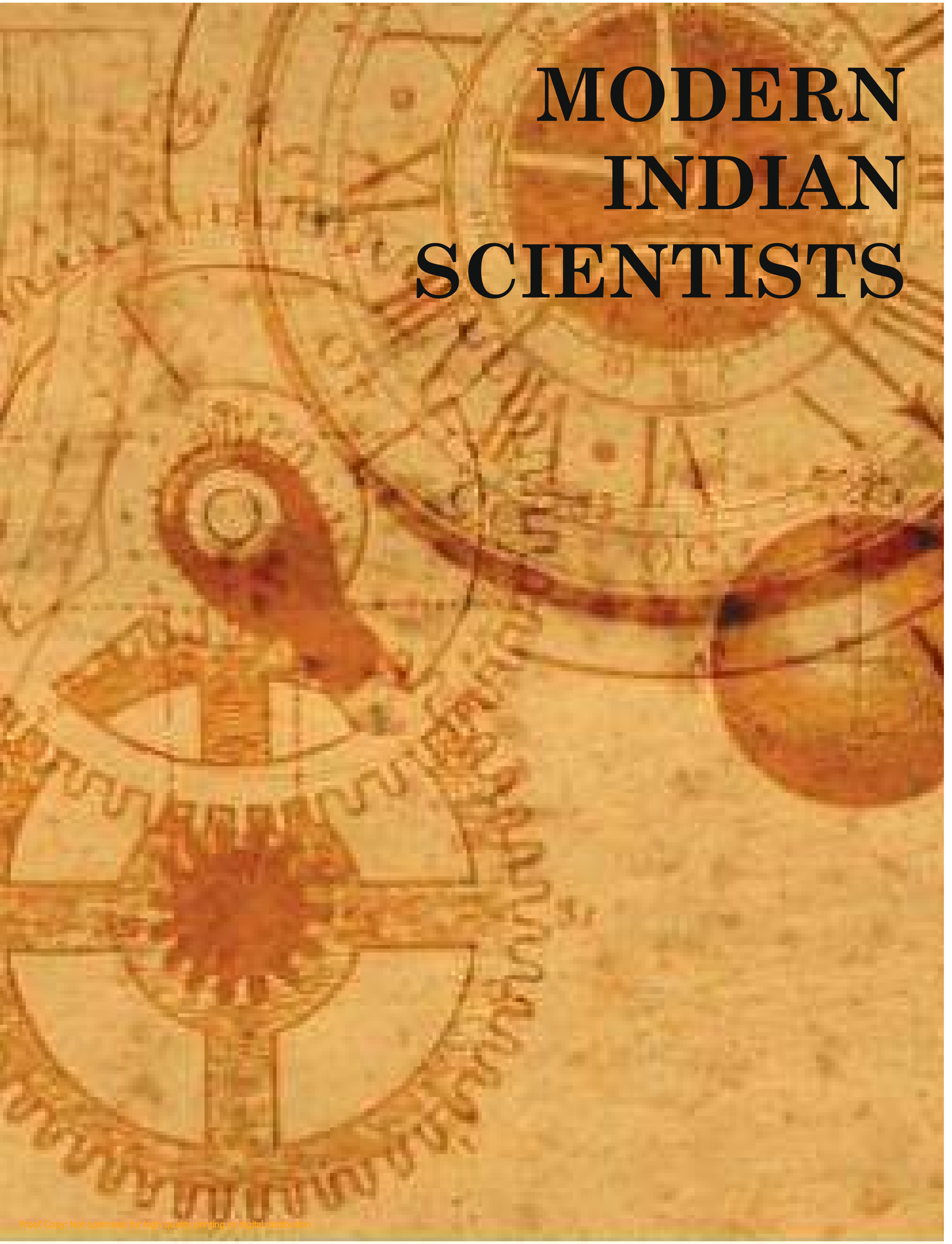
Sushruta, one of the earliest surgeons, Charaka, a medical genius, and Vagbhata are considered to be "The Trinity" of Ayurvedic knowledge, with Vagbhata coming after the other two. According to some scholars, Vagbhata lived in Sindh around the sixth century. Not much is known about him personally, except that he was most likely to have been a Buddhist, as he makes a reference to Lord Buddha in his writings, and his sons, grandsons, and disciples were all Buddhists. It is also believed that he was taught Ayurvedic medicine by his father and a Buddhist monk, named Avalokita.

The Aṣṭāṅgahṛdayasaṃhitā (Ah, "Heart of Medicine") is written in poetic language. The Aṣṭāṅgasaṅgraha (As, "Compendium of Medicine") is a longer and less concise work, containing many parallel passages and extensive passages in prose. The Ah is written in 7120 easily understood Sanskrit verses that present a coherent account of Ayurvedic knowledge. Ashtanga in Sanskrit means 'eight components' and refers to the eight sections of Ayurveda: internal medicine, surgery,

A manuscript of Ashtangahridyasamhita recovered from Sri Lanka

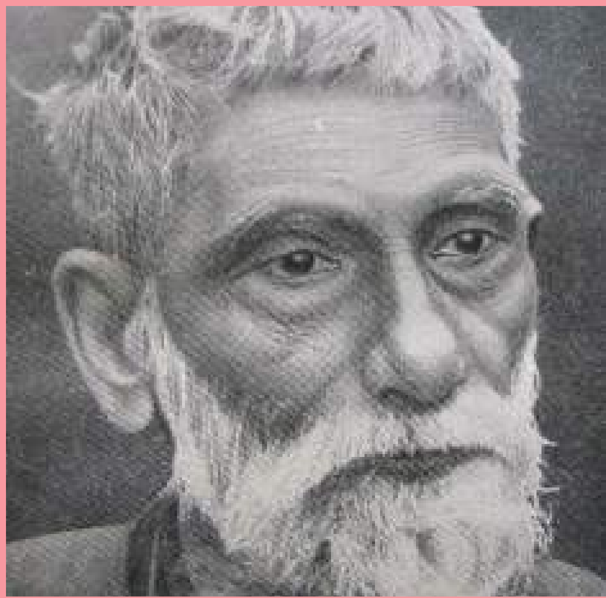
gynaecology and paediatrics, rejuvenation therapy, aphrodisiac therapy, toxicology, and psychiatry or spiritual healing, and ENT (ear, nose and throat). There are sections on longevity, personal hygiene, the causes of illness, the influence of season and time on the human organism, types and classifications of medicine, the significance of the sense of taste, pregnancy and possible complications during birth, Prakriti, individual constitutions and various aids for establishing a prognosis.

MODERN INDIAN SCIENTISTS



Acharya Prafulla Chandra Ray

Ray was born on 2 August 1861 in a village in the district of Jessore, now in Bangladesh. Ray's started in his village school, founded by his father. He then studied at the metropolitan College (Vidyasagar College) in Kolkata.He was a recipient of the prestigious Gilchrist Scholarship and studied at the Edinburgh University. In 1885, Ray obtained his BSc degree & in 1887 he was awarded the DSc degree of the Edinburgh University. After retiring from the Presidency College in 1916, Ray joined the University College of Science, Calcutta University at the invitation of Asutosh Mookerjee. He published about 120 research papers mostly in research journals of international repute. Ray conducted systematic chemical analysis of a number of rare Indian minerals with the object of discovering in them some of the missing elements in Mendeleev's Periodic Table. Prafulla Chandra Ray is the founder of the Indian school of modern chemistry.



Amal Kumar Raychaudhuri

Amal Kumar Raychaudhuri (4 September 1923 – 18 June 2005) was a leading Indian physicist, renowned for his research in general relativity and cosmology. His most significant contribution is the eponymous Raychaudhuri equation, which demonstrates that singularities arise inevitably in general relativity and is a key ingredient in the proofs of the Penrose–Hawking singularity theorems.
Raychaudhuri was also revered as a teacher during his tenure at Presidency College, Kolkata. Many of his students have gone on to become established scientists.

Raychaudhuri equation (RE), which is an important step in deriving the Hawking-Penrose singularity theorems. The equation is attributed to Amal K Raychaudhuri who used to teach at Presidency College, Kolkata. His equations leads to a solution in which the everlasting universe is not born in a Big Bang.

Anil Kumar Gain

Anil Kumar Gain (1 February 1919 – 7 February 1978) was an Indian mathematician and statistician best known for his works on the Pearson product-moment correlation coefficient in the field of applied statistics, with his colleague Ronald Fisher.
He received his Ph.D. from the University of Cambridge under the supervision of Henry Ellis Daniels, who was the then President of the Royal Statistical Society.
He was honoured as a Fellow of the Royal Statistical Society and the famous Cambridge Philosophical Society.

He later went on to found Vidyasagar University, naming it after the famous social reformer of the Bengali renaissance, Ishwar Chandra Vidyasagar.

Anna Mani

Anna Modayil Mani (Commonly known as Anna Mani) is one of the most distinguished Indian scientists in meteorological sciences. On realising the potential of solar energy as an alternate source of energy for a tropical country like India she took upon herself the task of generating data on seasonal and geographical distribution of solar energy in India. She worked on a number of projects for harnessing wind energy & on atmospheric ozone. In recognition of Anna Mani's phenomenal contribution to ozone studies, she was made a member of the International Ozone Commission.

Anna Mani died on 16 August 2001 at Thiruvananthapuram.

Asima Chatterjee

Asima Chatterjee (23 September 1917 – 22 November 2006) was an Indian chemist noted for her work in the fields of organic chemistry and phytomedicine. Her most notable work includes research on vinca alkaloids, and the development of anti-epileptic and anti-malarial drugs. She also authored a considerable volume of work on medicinal plants of the Indian subcontinent.

Chatterjee died on 23 November 2006 in Kolkata at the age of 89. Chatterjee was nominated by the President of India as a Member of Rajya Sabha from February 1982 till May 1990.

Asutosh Mookerjee

Asutosh was born in Kolkata (then Calcutta) on 28 June 1884 to Gangaprasad Mukhopadyhyay and Jagattarini Devi. His father was a well-known physician and his mother was known to be a woman of courage and considerable strength of character. Asutosh Mookerjee was one of the pioneer architects of Modern India. He was a distinguished mathematician of his time. He published about 20 original research papers in mathematics in national and international journals. He wrote a book in mathematics titled Geometry of Conics. He established the Calcutta Mathematical Society in 1908 and directed its activities as its President till his death.

Atma Ram

Atma Ram was born on 12 October 1908 in a small village named Pilana in Bijnor District of western Uttar Pradesh. His parents belonged to a lower middle class family. Atma Ram's contributions cover fundamental and applied sciences as well as technology of production. His most significant achievement was the development and production of optical glass. In those days it was a vitally strategic material, the technology of production of which was a closely guarded secret of ten countries in the world. Some of his work led to the development of entirely new industries in the country like the production of heat insulating materials from waste mica and foam glass for use in building, cold storage and refrigeration industries. Some of the articles, which were produced using technologies developed by Atma Ram Are: chemical porcelain, glass electrode for pH meters, coloured glasses, sun-glare glasses, ceramic and vitreous enamel colours and stains, and special refractories. He held 23 patents relating to his industrial work. His work on the origin of colour in copper-red glasses was of fundamental importance.

Birbal Sahni

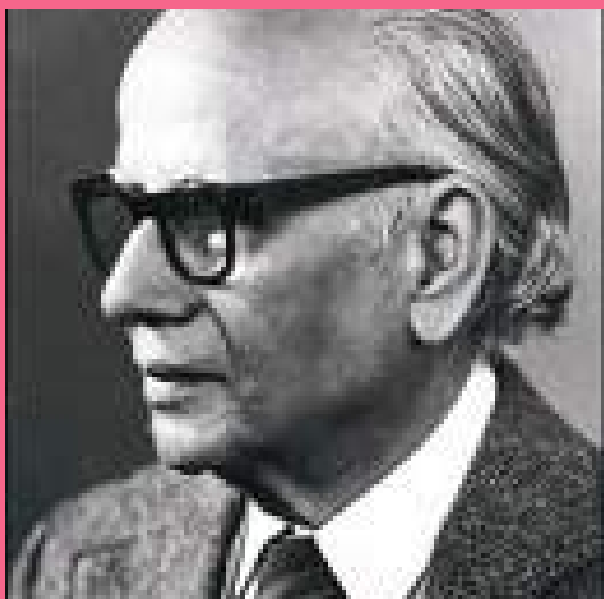
The renowned paleobotanist, Birbal Sahni, was born on November 14, 1891 in Shahpur District, now in Pakistan. He was the third son of Ishwari Devi and Lala Ruchi Ram Sahani. He studied from the Government College, Lahore and Punjab University. He graduated from Emmanuel College, Cambridge in 1914. After completion of his education, Birbal Sahni came back to India. He studied the fossils of the Indian subcontinent. He was the founder of Birbal Sahni Institute of Palaeobotany, Lucknow. Palaeobotany is a subject that requires the knowledge of both botany and geology. Birbal Sahni was the first botanist to study extensively about the flora of Indian Gondwana region. Sahni also explored the Raj Mahal hills in Bihar, which is a treasure house of fossils of ancient plants. Here he discovered some new genus of plants. For his studies on the technique of casting coins in ancient India he was awarded the Nelson Wright Medal of the Numismatic Society of India.
Sahni died on the night of April 10, 1949 .

Chandrasekhar Venkata Raman

Chandrasekhar Venkata Raman, popularly known as C. V. Raman, was the first Indian (and also the first Asian) Nobel Laureate in science. Raman's celebrated discovery, the Raman Effect, experimentally demonstrated that the light-quanta and molecules do exchange energy which manifests itself as a change in the colour of the scattered light. It was the most convincing proof of quantum theory of light. Albert Einstein (1879-1955) wrote: "C. V. Raman was the first to recognise and demonstrate that the energy of photon can undergo partial transformation with matter. I still recall vividly the deep impression that this discovery made on all of us…". Raman was awarded Nobel Prize in Physics in 1930 for his discovery. Raman scattering or the Raman Effect is the inelastic scattering of a photon. It was discovered by C. V. Raman and K. S. Krishnan in liquids, and by G. Landsberg and L. I. Mandelstam in crystals. The effect had been predicted theoretically by Adolf Smekal in 1923.

Dr. BP Pal

Dr B P Pal, the famous agricultural scientist, was born in Punjab on May 26, 1906. Dr Pal studied at St Michael's School in Maymyo, Burma. In 1929 Dr Pal qualified for the Masters degree in Botany at Rangoon University where he also won the Matthew Hunter Prize for topping among all science streams in the University. Dr Pal worked with Sir Frank Engledow on hybrid vigour in wheat at the coveted Plant Breeding Institute. In May 1965, Pal became the first Director-General of the Indian Council of Agricultural Research (ICAR), during which period the Green Revolution was launched with outstanding success. Dr Pal's major contribution to the scientific aspects of the Green Revolution was in the area of wheat genetics and breeding. He was elected a Fellow of the Royal Society in 1972 and received numerous awards including the Padma Vibhushan.



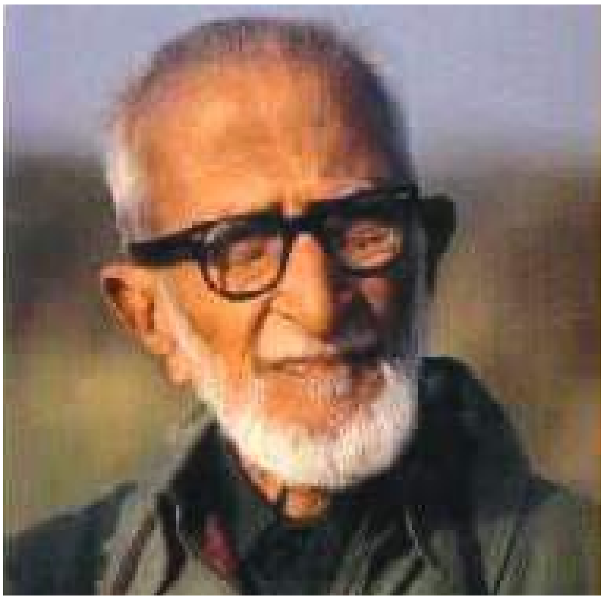
Dr. Har Gobind Khurana

Dr. Har Govind Khurana was born on January 9, 1922 in a small village called Raipur in Punjab (now in Pakistan).

Khurana had his preliminary schooling at home. Later he joined the DAV High Multan High School. He graduated in Science from Punjab University, Lahore, in 1943 and went on to acquire his Masters degree in Science in 1945. He joined the University of Liverpool for his doctoral work and got his Doctorate in 1948.

Khurana joined the University of Wisconsin in 1960, and 10 years later joined Massachusetts Institute of Technology (MIT). Dr. Khurana received the Nobel Prize in Physiology or Medicine in 1968 along with M W Nienberg and R W Holley for the interpretation of the genetic code, its function and protein synthesis. The Government of India honored him with Padma Vibhushan in 1969. He won numerous other prestigious awards, including the Albert Lasker award for medical research, National Medal of Science and the Ellis Island Medal of Honor. Dr Har Govind Khurana died in a hospital in Concord, Massachusetts, on November 9, 1911.

Dr. Salim Ali



Dr Salim Ali born on November 12, 1896 in Mumbai was orphaned at a very young age. Salim Ali was brought up by his maternal uncle, Amiruddin Tyabji who introduced him to nature.Ali was hired as guide lecturer in 1926 at the newly opened natural history section in the Prince of Wales Museum in Mumbai. He went on study leave in 1928 to Germany, where he trained under Professor Erwin Stresemann at the Zoological Museum of Berlin University. On his return to India in 1930, he discovered that the guide lecturer position had been eliminated due to lack of funds. In Kihim, a coastal village near Mumbai, he began making his first observations of the Baya or the Weaver bird. The publication of his findings on the bird in 1930 brought him recognition in the field of ornithology. Salim Ali was very influential in ensuring the survival of the BNHS and managed to save the 200-year old institution by writing to the then Prime Minister Pandit Nehru. He was honoured with a Padma Vibhushan in I983. He died at the age of 90, on June 20, 1987.

Gopalasundaram Narayana Ramachandran

Gopalasamudram Narayana Ramachandran was born on 8 October 1922 in Ernakulam near Kochi (then Cochin) in Kerala. He had his early schooling in a government school in Ernakulum. After the Intermediate examination, Ramachandran joined the St. Joseph's College in Trichy in 1939. Ramachandran joined Indian Institute of Science, Bengaluru, for his MSc degree. Ramachandran obtained his MSc degree in 1944 and started working for his doctoral degree under the supervision of C. V. Raman. After obtaining his Doctor of Science degree in 1947 he planned to go to Cambridge in England to work in the Cavendish Laboratory, where Sir William Lawrence Bragg was the Director. After finishing his doctoral work in Cambridge, Ramachandran returned to India in June 1949. In 1970, Ramachandran joined the Indian Institute of Science. He was given the responsibility of starting a new department of molecular biophysics.
Ramachandran Died on 7 April 2001.

Homi Jehangir Bhabha

Homi Jehangir Bhabha is known as the chief architect of India's atomic energy programme. Bhabha was born on 30 October 1909. In 1940, Bhabha joined the Department of Physics of the Indian Institute of Science (IISc), Bengaluru, where a Readership in Theoretical Physics was specially created for him. At the time Bhabha joined the Physics Department of the IISc it was headed by C. V. Raman. At the IISc, Bhabha guided research on cosmic rays. The Tata Institute of Fundamental Research (TIFR) in Mumbai, was inaugurated in 1945 due to Bhabha's detemination. Later Bhabha built a new laboratory entirely devoted to atomic energy research and development, which was later called Bhabha Atomic Research Centre (BARC). Bhabha was the first Chairman of the Atomic Energy Commission.
Bhabha was killed in a air-crash near the Mont Blanc peak of the Alps on 24 January 1966, while he was on his way to Vienna to attend a meeting of the International Atomic Energy Agency.

Jagadish Chandra Bose

Jagadish Chandra was born on 30 November 1858 in Mymensingh (now in Bangladesh).JC Bose is considered as the first scientist from India under the Galilean Order. Bose was a pioneer in microwave optics technology. He was the first to show that semiconductor rectifiers could detect radio waves. Bose's galena receiver was amongst the earliest examples of a led sulphide photo conducting device. Bose demonstrated that plant tissues under different kinds of stimuli like mechanical, application of heat, electric shock, chemicals and drugs, produce electric response similar to that produced by animal tissues. He also tries tried to demonstrate that similar electric response to stimulation could be noticed in certain inorganic systems. For his investigations Bose invented several novel and highly sensitive instruments. Among these the most important was the Crescograph, an instrument for measuring the growth of plant. I

Kalpana Chawla

Kalpana Chawla was born on July 1,1961 in Haryana's Karnal district. She was inspired by India's first pilot J R D Tata and always wanted to fly. She did her schooling from Karnal's Tagore School, and later studied Aeronautical Engineering from Punjab University. After obtaining a Master of Science degree in aerospace engineering from University of Texas in 1984, four years later, Dr Chawla earned a doctorate in aerospace engineering from University of Colorado. In the same year, she started working at NASA's Ames Research Center. She was a strict vegetarian and was an avid music lover. Chawla joined NASA's space programme in 1994 and her first mission to space began on November 19, 1997 as part of a 6-astronaut crew on Space Shuttle Columbia Flight STS- 87. She logged more than 375 hours in space, as she travelled over 6.5 million miles in 252 orbits of the earth during her first flight. Chawla was one of the seven crew members killed in the Space Shuttle Columbia disaster in 2003.

Manali Kallat Vainu Bappu

Vainu Bappu is regarded as the 'main architect of revival of astronomical studies in India'. He played an instrumental role in establishing a number of astronomical institutions in India including the Indian Institute of Astrophysics in Bengaluru. Vainu Bappu was born in Madras (now Chennai) on 10 August 1927. His father Sunanna Bappu was an astronomer at the Nizamiah Observatory, Hyderabad. His mother was Manali Kukuzhi. In 1957, Olin C. Wilson and M. K. Vainu Bappu reported on the remarkable correlation between the measured width of the aforementioned emission line and the absolute visual magnitude of the star. This is known as the Wilson–Bappu effect. Bappu was the first President of the Astronomical Society of India (1973-74). He served as Vice President (1967-1973) and President (1979) of the International Astronomical Union. Bappu died on 19 August 1982 in Munich, Germany. At the time of his death he was just 55 years old.

Meghnad Saha

Meghnad Saha was born on the 6 October, 1893 in a village near Dhaka in Bangladesh. He graduated from Presidency College with Mathematics major under the University of Calcutta. After M Sc. Meghnad decided to do research in Physics and Applied Mathematics. Meghnad Saha made remarkable contribution to the field of Astrophysics. He went abroad and stayed for two years in London and Germany. In 1927, Meghnad Saha was elected as a fellow of London's Royal Society. In 1947, he established Institute of Nuclear Physics which later was named after him as Saha Institute of Nuclear Physics. Saha was also elected as the Member of Parliament. The Saha ionization equation, also known as the Saha–Langmuir equation, is an expression that relates the ionization state of an element to the temperature and pressure.

Mokhagundam Visvesvaraya

Sir Mokshagundam Visvesvaraya , KCIE (popularly known as Sir MV; 15 September 1860–14 April 1962 was a otable Indian engineer, scholar, statesman and the Diwan of Mysore from 1912 to 1918. He is a recipient of the Indian Republic's highest honour, the Bharat Ratna, in 1955. He was knighted as a Knight Commander of the British Indian Empire (KCIE) by King George V for his contributions to the public good. Every year, on his birthday, 15 September is celebrated as Engineer's Day in India in his memory. He is held in high regard as a pre-eminent engineer of India. He was the chief designer of the flood protection system for the city of Hyderabad in Telangana, as well as the chief engineer responsible for the construction of the Krishna Raja Sagara dam in Mandya. He also designed and patented a system of automatic weir water floodgates that were first installed in 1903 at the Khadakvasla Reservoir near Pune. Visvesvaraya achieved celebrity status when he designed a flood protection system for the city of Hyderabad.

Panchanan Maheshwari

Born in November 1904 in Jaipur, Rajasthan, Panchanan Maheshwari is a famous biologist. Maheshwari invented the technique of test-tube fertilisation of angiosperms. Maheshwari's technique immediately opened up new avenues in plant embryology and has applications in economic and applied botany. Cross-breeding of many flowering plants which cannot crossbreed naturally can be done now. He pursued his postgraduate university education in Botany at Allahabad University. Way back in 1950 he talked of contacts between embryology, physiology and genetics. He also emphasized the need of initiation of work on artificial culture of immature embryos. His work on test tube fertilisation and intra- ovarian pollination won worldwide acclaim. Till his death in May 1966, he was editing his journal Phytomorphology.

PC Mahalanobis

Mahalanobis is remembered by Indians as an Indian scientist and as an applied statistician. His most significant contribution in the field of statistics was the Mahalanobis Distance. In the year 1913, Mahalanobis left for England for studies and came in contact with S Ramanujan, the famous mathematician from India. After completion of his studies, he returned to India and was invited by the Principal of Presidency College to take classes in Physics.The meetings and discussions at Presidency College led to the formal establishment of the Indian Statistical Institute and were formally registered on April 28, 1932. Initially the Institute was in the Physics Department of Presidency College, but later with passing time the institute expanded. The most important contributions of Mahalanobis are related to large-scale sample surveys. Mahalanobis was honoured with the second highest civilian award of the country, Padma Vibhushan. Mahalanobis died on June 28, 1972 at the age 78. In year 2006, Government of India declared June 29, the birthday of Mahalanobis, as the National Statistical Day.

Ronald Ross

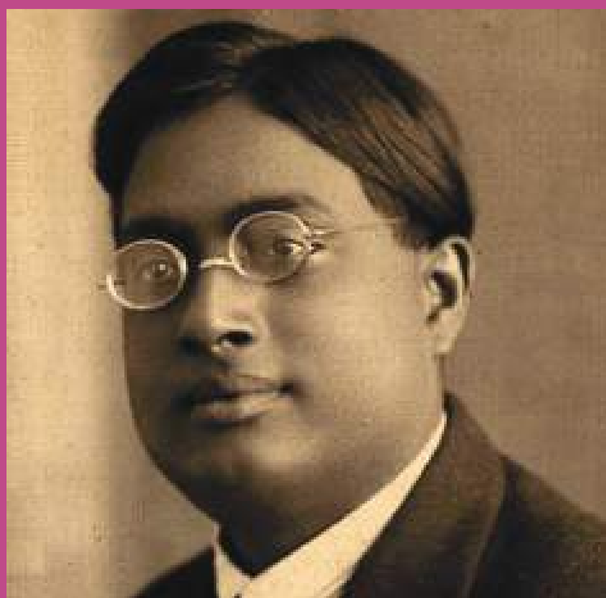
Ronald Ross was born in India in 1857 at Almora district in Uttarakhand. His father was a general in the British Army in India. Ross lived in India until he was eight. He was sent to a boarding school in England. He later studied medicine from St Bartholomew Hospital in London. Ronald Ross proved in 1897 the long-suspected link between mosquitoes and malaria. Till that time it was believed that malaria was caused by breathing in bad air and living in a hot, humid and marshy environment. Ross studied malaria between 1882 and 1899. In 1902, Ross was awarded the Nobel Prize in Medicine for his remarkable work on malaria and was conferred Knighthood as mark of his great contribution to the world of medicine. In 1926, he became Director of the Ross Institute and Hospital for Tropical Diseases in London, which was founded in his honour.

Satish Dhawan

Satish Dhawan was born on 25 September 1920 in Srinagar, Jammu & Kashmir. Satish Dhawan shaped India's space programme by translating Vikram Sarabhai's dream into reality. In 1943, he moved to the USA where he first attended the University of Minnesota, Minneapolis and completed a Bachelor of Engineering degree in Mechanical Engineering in 1945. In 1947 he obtained a Master of Science in Aerospace Engineering and Aeronautical Engineer's degree from the California Institute of Technology (Caltech). From Caltech he also obtained a double PhD in Mathematics and Aerospace Engineering under the supervision of Hans W. Liepmann (1914-2009). In 1962, at the age of 42, he became the youngest Director of the Indian Institute of Science, Bengaluru. Dhawan took up charge of India's space programme in September 1972. He became Chairman of the newly established Space Commission, Secretary to the Department of Space and Chairman of ISRO. It may be noted that the space Commission and the Department of Space were established on 1 June 1972. Dhawan died on 3 January 2002 at the age of 81.

Satyendra Nath Bose

Satyendra Nath Bose has been in the news of late in connection with the discovery of 'Higgs boson' or popularly called the 'God Particle'. . He is known for his work in Quantum Physics. He is famous for the 'Bose-Einstein Theory' and a kind of particle in atom has been named after his name as Boson. Satyendranath Bose was born on January 1, 1894 in Kolkata. In 1926, Satyendra Nath Bose became a Professor of Physics in Dhaka University. Though he had not completed his doctorate till then, he was appointed as Professor on Einstein's recommendation. In 1929, Satyendranath Bose was elected Chairman of the Physics of the Indian Science Congress and in 1944 elected full chairman of the Congress. In 1958, he was made a Fellow of the Royal Society, London. Satyendra Nath Bose was honored with 'Padma Bhushan' by the Government of India. He died in Kolkata on February 4, 1974.



Shanti Swarup Bhatnagar

Shanti Swarup Bhatnagar was born on 21 February, 1894 at Bhera, district Shapur, Punjab (now in Pakistan). Bhatnagar passed the intermediate Examination of the Punjab University and joined the Forman Christian College for the BSc degree. Later he joined the MSc course of the Punjab University. He obtained his MSc degree in 1919. After MSc, Bhatnagar moved to England for higher studies. Bhatnagar was instrumental in setting up of the Council of Scientific and Industrial Research (CSIR). He was its Founder Director (a post later re-designated as Director General). This became a major agency for scientific and industrial research in independent India. Bhatnagar played an instrumental role in the establishment of the National Research and Development Corporation (NRDC), which was visualised to bridge the gap between research and development.

Srinivasa Ramanujam

Srinivasa Ramanujan was a mathematician par excellence. He is widely believed to be the greatest mathematician of the 20th Century. Srinivasa Ramanujan made significant contribution to the analytical theory of numbers and worked on elliptic functions, continued fractions, and infinite series.Srinivasa Ramanujan was born on December 8, 1820 in the town of Erode, in Tamil Nadu. On 16 March 1916 Ramanujan graduated from Cambridge with a Bachelor of Science by Research. He had been allowed to enrol in June 1914 despite not having the proper qualifications. Ramanujan's dissertation was on Highly composite numbers and consisted of seven of his papers published in England.His most famous work was on the number p(n) of partitions of an integer n into summands. Ramanujan sailed to India on 27 February 1919 arriving on 13 March. However his health was very poor and, despite medical treatment, he died on April 26, 1920

Subramanyan Chandrasekhar

Subrahmanyan Chandrasekhar was born on October 19, 1910 in Lahore. In July 1930, he was awarded a Government of India scholarship for graduate studies in Cambridge, England. Subrahmanyan Chandrasekhar completed his PhD degree at Cambridge in the summer of 1933. In October 1933, Chandrasekhar was elected to a Prize Fellowship at Trinity College for the period 1933-37. In 1936, while on a short visit to Harvard University, Subrahmanyan Chandrasekhar was offered a position as a Research Associate at the University of Chicago and remained there ever since. The Chandrasekhar limit is the maximum mass of a stable white dwarf star. The currently accepted value of the limit is about 1.39 (2.765 × 1030 kg). The Chandra X-ray Observatory (CXO), is a space observatory launched on STS-93 by NASA on July 23, 1999. Subrahmanyan Chandrasekhar was awarded (jointly with the nuclear astrophysicist W A Fowler) the Nobel Prize in Physics in 1983. He died on August 21, 1995

Thiruvenkata Rajendra Sheshadri

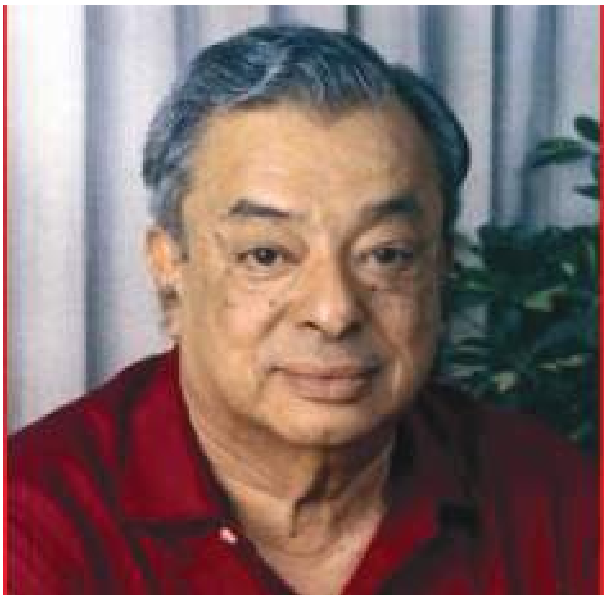
Thiruvenkata Rajendra Seshadri was one of the most accomplished chemists of India. Seshadri was born on 3 February 1900 in Kulitalai, near Tiruchirapalli.

The work of Seshadri and his group on natural products can be groupd into four areas, namely, structure elucidations, synthesis and synthetic methods, stereochemistry, and biogenetic theory. Among the compounds whose structures were elucidated were: Gossytrin and related pigments of cotton and hibiscus flowers, pedicinin, pedicellic acid and related compounds, mangiferin, dalbergin, latifolin, ferreirin and homoferreirin, pongamol, karanjin, auranetin prudomestin, neptitrin, pedaliin, cupressulflavone, theleporic acid, virensic acid, tingenone, enhydrin, santalin, and alpha terthienyl methanol.

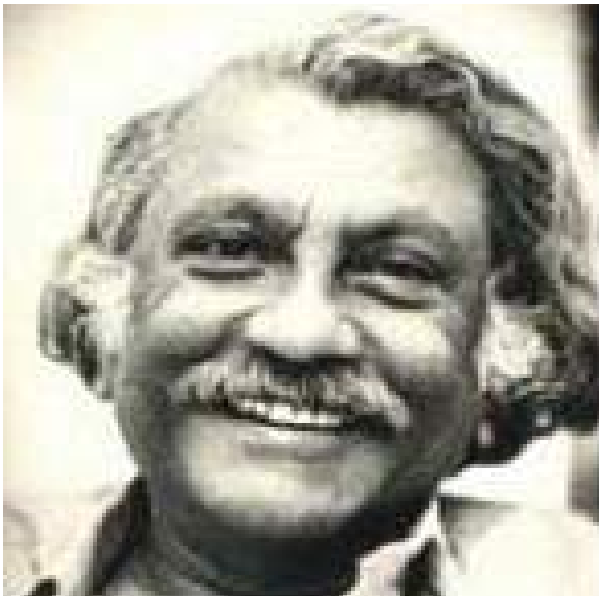
In 1917, Seshadri joined the Madras Presidency College to study the BSc (Honours) course in chemistry. His research supervisor was B. B. Dey. Seshadri's work with Dey on the synthesis of quinolino-pyrones earned him two prizes from the Madras University—the Sir William Wedderburn Prize and the Curzon Prize. He died on 27 September 1975

Verghese Kurien

Fondly called the ‘Milk Man of India’, Verghese Kurien was born on 26 November 1921 in Kozhikode, Kerala. His father was a civil surgeon in Cochin. He graduated in Physics from Loyola College, Madras in 1940 and then did BE (Mechanical) from the University of Madras. After completing his degree, he joined the Tata Steel Technical Institute, Jamshedpur, from where he graduated in 1946. He then went to USA on a government scholarship to earn his Master of Science in Metallurgical Engineering from Michigan State University. He is famously known as the architect of Operation Flood —the largest dairy development programme in the world. Kurien helped and thus engineered the White Revolution in India, and made India the largest milk producer in the world. He is the founder of the Gujarat Co- operative Milk Marketing Federation, the cooperative organization that manages the Amul food brand. Verghese Kurien died on 9 September 2012 after a brief spell of illness in Nadiad, near Anand at the age of 90.



Venkatraman Radhakrishnan



Venkatraman Radhakrishnan (18 May 1929 – 3 March 2011) was a space scientist and member of the Royal Swedish Academy of Sciences. He was Professor Emeritus of the Raman Research Institute in Bangalore, India, where he had been Director from 1972 to 1994. Professor Radhakrishnan was born in Tondaripet, a suburb of Madras to Nobel laureate physicist Sir Chandrasekhara Venkata Raman and his wife Lokasundari Ammal . He served as the Chairman of Commission J (Radio Astronomy) of the International Union of Radio Sciences (1981–1984). He was an internationally acclaimed Astrophysicist and also renowned for his design and fabrication of ultralight aircraft and sailboats. He was a Senior Research fellow of the California Institute of Technology, USA . The University of Amsterdam conferred the most prestigious Doctor Honoris Causa degree on Prof. Radhakrishnan in 1996.

Vikram Ambalal Sarabhai

Vikram Ambalal Sarabhai was born on 12 August 1919 in a wealthy family at Ahmedabad. After completing his Intermediate Science examination from Gujarat College, he went to Cambridge in 1937 and from where he obtained his Tripos in Natural Sciences in 1940. In 1947, he was awarded PhD by the Cambridge University for his thesis entitled "Cosmic Ray investigations in Tropical Latitudes". After getting his PhD, he returned to India. His greatest contribution was the founding of the Indian Space Research Organization (ISRO). India wanted to achieve self-reliance in this field and a series of installations such as Space Science and Technology Center (SSTC), Rocket Fabrication Facility (RFF) and Propellant Fuel complex came up in Thumpa. The first India-made rocket, styled Rohini, was launched from a pad in Thumpa in November 1967. The credit for the founding of India's satellite launching station at Shreeharikotta also goes to Dr. Vikram. Sarabhai died on 30 December 1971 at Kovalam, Thiruvanathapuram, Kerala.

Yellapragada SubbaRow

Yellapragada SubbaRow was the man behind the development of many wonderful antibiotics such as tetracycline, antifolate cancer drugs, antifilarial drugs, antimalarial drugs and so on. Yellapragada SubbaRow was born on 12 January 1895 in Bhimavaram in the West Godavari district of Andhra Pradesh. SubbaRow was awarded the Diploma of the Harvard University School of Tropical Medicine on 1 June 1924. After completing the Diploma SubbaRow became interested in biochemistry and started working with Cyrus Hartwell Fiske. He got his PhD degree in 1930. He continued to work in the Harvard Medical School till 1940 when he moved to Lederle Laboratories.
Folic Acid came out of Yellapragada SubbaRow's search of 18 long years for APAF the anti-pernicious anaemia factor. Tetracyclines have saved millions of lives over the last 50 years. Aureomycin was presented to medicine in 1948, the year SubbaRow died. It was the first broad-spectrum antibiotic, that is effective against both gram-positive and gram-negative germs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CONTEMPORARY INDIAN SCIENTISTS

Animesh Chakraborty

Animesh Chakraborty (born 30 June 1935) is a Bengali Indian academic and a professor of chemistry. In 1975, he was awarded the Shanti Swarup Bhatnagar Prize for Science and Technology in chemistry by the Council of Scientific and Industrial Research.
He had started as a research associate at the MIT and Harvard. He had also served as professor and head of the department of chemistry at the Indian Institute of Technology Kanpur, and as professor and head of the department of inorganic chemistry at the Indian Association for the Cultivation of Science at the University of Calcutta, and as a visiting professor at the Texas A&M University. He was also the Hindustan Lever Research Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research. He had guided fifty eight PhD's and numerous postdoctoral associates, many of the former students have become well known personalities .

Abhas Mitra

Abhas Mitra (born 18 June 1955) is an Indian astrophysicist best known for his distinct views on several front-line astrophysics concepts, particularly black holes and Big Bang Cosmology. He has regularly questioned the mainstream cosmological concepts of the "big bang" and "black holes". He claims to have offered exact proofs that:

Mitra is associated with the `Himalayan Gamma Ray Observatory being set up at Han Leh jointly by Tata Institute of Fundamental Research, Bhabha Atomic Research Centre and Indian Institute of Astrophysics. He is also an Adjunct Prof. in Homi Bhabha National Science Institute since 2010. Dr. Mitra is also a member of the International Astronomical Union.

Abhay Vasant Ashtekar

Abhay Vasant Ashtekar (born July 5, 1949) is an Indian theoretical physicist. He is the Eberly Professor of Physics and the Director of the Institute for Gravitational Physics and Geometry at Pennsylvania State University. As the creator of Ashtekar variables, he is one of the founders of loop quantum gravity and its subfield loop quantum cosmology. He has also written a number of descriptions of loop quantum gravity that are accessible to non-physicists. In 1999, Ashtekar and his colleagues were able to calculate the entropy for a black hole, matching a legendary 1974 prediction by Hawking.

Anil Bharadwaj

Anil Bhardwaj (born 1 June 1967) is the Director of the Space Physics Laboratory, Vikram Sarabhai Space Centre, ISRO, Trivandrum, India.
He is the recipient of the Shanti Swarup Bhatnagar Award in 2007, and was awarded NRC Senior Research Associteship by US National Academy of Science in 2003. He worked at Marshall Space Flight Center, Huntsville, AL, during January 2004 to October 2005. He was awarded fellowship grant by United Nations Office of Outer Space Affairs, Vienna, Austria, in 1996. He is a Fellow of the Indian Academy of Sciences, Bangalore; Indian National Science Academy, New Delhi; National Academy of Sciences, India, Allahabad; Indian Geophysical Union, Hyderabad; and Kerala Academy of Sciences, Trivandrum. He was also awarded ISRO Team Excellence Award for Chandrayaan-1 Science and Mission in 2008. He is a member of International Academy of Astronautics and International Astronomical Union. Currently, he is the member of INSA-ICSU Committee for COSPAR, SCOSTEP and URSI, and Vice-Chair of COSPAR Commission.

Anil Kakkodkar

Dr Anil Kakodkar, the famous Indian nuclear scientist was born on 11 November 1943 in the village Barawani, Madhya Pradesh. Kakodkar joined VJTI in Bombay University in 1963 to obtain a degree in Mechanical Engineering. In the year 1964, Anil Kakodkar joined the Bhabha Atomic Research Centre (BARC). He was Chairman of the Atomic Energy Commission of India (AECI) and Secretary to the Government of India, Department of Atomic Energy. He was also the Director of the Bhabha Atomic Research Centre at Trombay during the period 1996-2000 before leading India's nuclear programme. Anil Kakodkar also was also in the core team of architects of India's Peaceful Nuclear Tests that were conducted during the years 1974 and 1998. He also led the indigenous development of the country's Pressurised Heavy Water Reactor Technology. In the year 1996, Anil Kakodkar became the youngest Director of the BARC after Homi Bhabha himself. He strongly advocates the cause of India's self- reliance by using Thorium as a fuel for nuclear energy.

G. Madhavan Nair

Dr G Madhavan Nair was born on October 31, 1943 in Thiruvananthapuram, Kerala. This former chairperson of the India Space Research Organisation (ISRO) is known as the man behind , India's first unmanned mission to the moon. Nair did his graduation in Electrical and Communication Engineering from the University of Kerala in 1966. He then underwent training at Bhabha Atomic Research Centre (BARC), Bombay. He joined the Thumba Equatorial Rocket Launching Station (TERLS) in 1967. During his six years tenure at ISRO, as many as 25 successful missions were accomplished. As a result, more than 31,000 classrooms have been connected under the EDUSAT network and telemedicine is extended to 315 hospitals - 269 in remote/rural/district hospitals including 10 mobile units and 46 super specialty hospitals. He also initiated the Village Resource Centres (VRCs) scheme through satellite connectivity, which aims at improving the quality of life of the poor people in the villages. He was awarded the Padma Vibhushan, India's second highest civilian award in

Jayant Narlikar

Jayant Vishnu Narlikar (born 19 July 1938) is an Indian astrophysicist. Narlikar is a proponent of steady state cosmology. He developed with Sir Fred Hoyle the conformal gravity theory, commonly known as Hoyle–Narlikar theory. It synthesises Albert Einstein's Theory of Relativity and Mach's Principle. It proposes that the inertial mass of a particle is a function of the masses of all other particles, multiplied by a coupling constant, which is a function of cosmic epoch. In cosmologies based on this theory, the gravitational constant G decreases strongly with time. In 1960, he won the Tyson Medal for astronomy. During his doctoral studies at Cambridge, he won the Smith's Prize in 1962. During 1994–1997, he was the President of the Cosmology Commission of the International Astronomical Union. India's second highest civilian honour, Padma Vibhushan, was awarded to him in 2004 for his research work.

Manindra Agarwal

Manindra Agrawal (born 20 May 1966) is a professor at the Department of Computer Science and Engineering and the Dean of Faculty Affairs (DoFA) at the Indian Institute of Technology, Kanpur. He was also the recipient of the first Infosys Prize for Mathematics. and the Shanti Swarup Bhatnagar Award in Mathematical Sciences in 2003. He has been honored with Padma Shri in 2013. He co-created the AKS primality test with Neeraj Kayal and Nitin Saxena, for which he and his co-authors won the 2006 Fulkerson Prize, and the 2006 Gödel Prize. He was also awarded with 2002 Clay Research Award for this work.The test is the first unconditional deterministic algorithm to test an n-digit number for primality in a time that has been proven to be polynomial in n. In September 2008, Agrawal was chosen for the first Infosys Mathematics Prize for outstanding contributions in the broad field of mathematics.

Manjul Bhargava

Manjul Bhargava (born 8 August 1974) is a Canadian-American mathematician of Indian origin. He is the R. Brandon Fradd Professor of Mathematics at Princeton University, the Stieltjes Professor of Number Theory at Leiden University, and also holds Adjunct Professorships at the Tata Institute of Fundamental Research, the Indian Institute of Technology Bombay, and the University of Hyderabad. He is known primarily for his contributions to number theory. Bhargava was awarded the Fields Medal in 2014. In 2015, Bhargava was awarded the Padma Bhushan, the third highest civilian award of India. According to the International Mathematical Union citation, he was awarded the prize "for developing powerful new methods in the geometry of numbers, which he applied to count rings of small rank and to bound the average rank of elliptic curves.

MS Swaminathan

Maankombu Sambasivan Swaminathan was born on August 7, 1925 in Kumbakonam, Tamil Nadu. This famous geneticist is known as the man behind India's 'Green Revolution', a programme, which revolutionised India's farming scenario by introducing high yielding crops. In 1952, he earned his PhD in genetics from Cambridge University, then did further studies at the Wisconsin University. Swaminathan brought into India seeds developed in Mexico by US agricultural guru Norman Borlaug and created a wheat plant that yielded much more grain than traditional types.He served as the Director General of the Indian Council of Agricultural Research from 1972 to 1979 and became Union Minister for Agriculture from 1979 to 1980. He served as Director General of the IRRI and became President of the International Union for the Conservation of Nature and Natural Resources. He received the Ramon Magsaysay Award for Community Leadership in 1971.

M.S. Valiathan

M. S. Valiathan, as he is popularly known, can be best described as an intellectual wanderer par excellence. He was born to Marthanda and Janaki Varma in 1934. His early education was at a government school in Mavelikara and then at University College, Trivandrum. Valiathan's medical education began at the University of Kerala, Trivandrum, where he studied from 1951 to 1956. He later went to University of Liverpool in Liverpool, England as a surgical trainee and received his fellowship from the Royal College of Surgeons of Edinburgh and England in 1960. After a brief stint as a faculty member at the Post Graduate Institute of Medical Education and Research, Chandigarh he underwent further training in cardiac surgery at the Johns Hopkins, George Washington, and Georgetown University Hospitals, USA. At Sree Chitra Tirunal Center, Trivandrum, Dr. Valiathan and his team developed a mechanical valve with a tilting-disc design. The Chitra-TTK valve that is currently marketed is the fourth model that was developed over a decade of collaborative effort in India.

Ashoke Sen

Ashoke Sen, (born 1956) is an Indian theoretical physicist and distinguished professor at the Harish-Chandra Research Institute, Allahabad. He also is the Morningstar Visiting professor at MIT and a distinguished professor at the Korea Institute for Advanced Study. His main area of work is String Theory. He was among the first recipients of the Fundamental Physics Prize “for opening the path to the realisation that all string theories are different limits of the same underlying theory”, set up by the Russian billionaire Yuri Milner. Ashoke Sen made huge contributions to string theory, including his landmark paper on strong-weak coupling duality or S-duality, which was influential in changing the course of research in the field. He pioneered the study of unstable D-branes and made the famous Sen conjecture about open string tachyon condensation on such branes. In 1998 he won the fellowship of the Royal Society on being nominated by the theoretical physicist Stephen Hawking. Recently he has joined National Institute of Science Education and Research (NISER), Bhubaneswar, India as an honorary fellow. He received Dirac's Medal in 2014 . He also received Padma Bhushan in 2013.

Sabeer Bhatia

Sabeer Bhatia is an entrepreneur who is mostly known as founder of Hotmail email service. Sabeer Bhatia was born in Punjab (India) on 30 December, 1968. Tough he was born in Punjab, He grew up in Bangalore. Sabeer has got his primary education from The Bishop's School in Pune and from St. Joseph's Boys' High School in Bangalore. He had done his B.S degree from California Institute of Technology and M.S. degree on electrical engineering from the Stanford University. Sabeer started his career at Apple computers as a hardware engineer. During that time he got the idea of Hotmail. Sabeer Bhatia has got many awards. TIME named him as a "People to Watch" in international business in 2002.

Satya Nadella

Satya Nadella is an Indian engineer who has joined the league of technological wizards like Steve Jobs and Bill Gates by the virtue of his great work and dedication. Nadella's educational background undoubtedly played a great role in shaping his technical and leadership abilities. After pursuing a degree in 'Electrical Engineering' from the reputed 'Manipal Institute of Technology' located in India, this tech wizard relocated to the United States. Here, he studied at esteemed institutions like the 'University of Wisconsin' and the 'Booth School of Business'. Nadella's life changed completely after he joined the IT giant 'Microsoft'. Slowly but steadily he grabbed bigger opportunities at the enterprise and went on to manage several divisions of the company. One of Satya's path-breaking accomplishments within the firm was to pave the way for the cloud computing technology, which later went on to become a trendsetter. One of Nadella's greatest accomplishments was pioneering the 'Cloud computing' division of 'Microsoft'.

Sundar Pichai

Sundar Pichai is a computer engineer and the current CEO of Google Inc. The technology giant Google, which specializes in Internet-related services and products, underwent a major corporate restructuring in 2015 following which Alphabet Inc was launched as its parent company with co-founders Larry Page as its CEO and Sergey Brin as President. Pichai, who had been serving as Google's head of Products and Engineering, was named the new CEO of Google which is the biggest company under Alphabet Inc. Pichai had joined Google years ago in 2004 as a product manager and led the innovative efforts for several of Google's products including Google Chrome and Chrome OS which went on to become highly successful. Eventually he took over the management of other Google products like Gmail and Google Docs, and rose through the ranks rapidly. Born in Chennai, India, having received his education from some of the most prestigious institutions in the world, he worked in engineering and product management at Applied Materials and in management consulting at McKinsey & Company before becoming a part of Google.

Sunita Williams Pandya

Born on 19 September 1965 to Dr Deepak and Bonnie Pandya at Ohio in the US, Sunita Williams Pandya, holds three records for female space Travelers, longest space flight (195 days) number of space walks (four) and total time spent on space walks (29 hours and 17 minutes). As of November 2012, Williams has made seven spacewalks totaling 50 hours and 40 minutes putting her in No. 5 on the list of most experienced spacewalkers. Williams's roots on her father's side go back to Gujarat in India. As for her education, Williams attended Needham High School in Needham, Massachusetts, graduating in 1983. She went on to receive a Bachelor of Science degree in Physical science from the United States Naval Academy in 1987, and a Master of Science degree in Engineering Management from Florida Institute of Technology in 1995. She took with her a copy of Bhagavad Gita and an idol of Ganesha when she visited the International Space Station on her record-breaking space flight.

Thanu Padmanabhan

Thanu Padmanabhan (born 10 March 1957) is an Indian theoretical physicist and cosmologist whose research spans a wide variety of topics in Gravitation, Structure formation in the universeand Quantum Gravity. He has published more than 260 papers and reviews in international journals and ten books in these areas. Many of his contributions, especially those related to the analysis and modelling of dark energy in the universe and the interpretation of gravity as an emergent phenomenon, have made significant impact in the field.

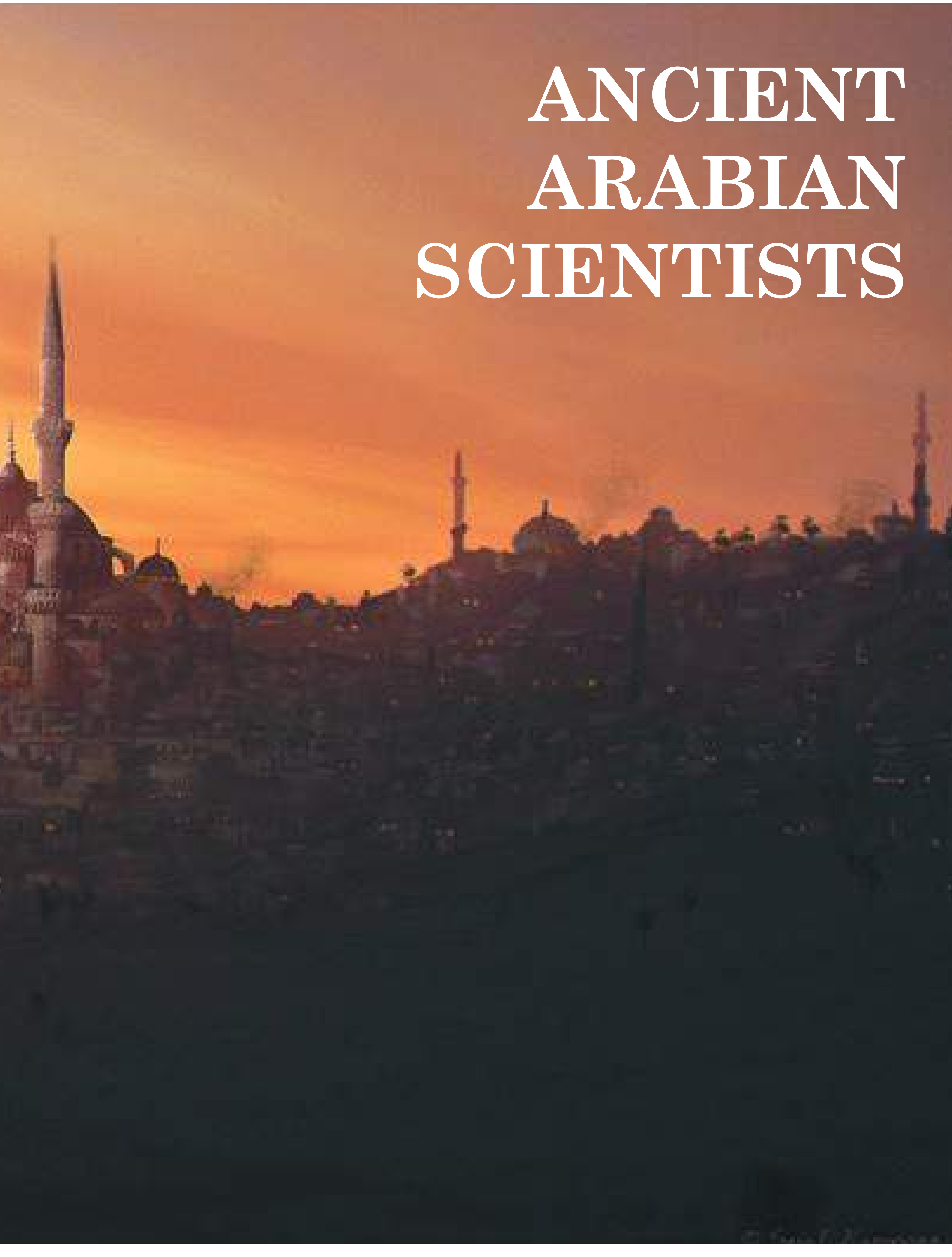
Venkatraman Ramakrishnan

Venkatraman Ramakrishnan was born in Chidambaram, a small town in Cuddalore district in Tamil Nadu in 1952. He migrated to America to do his higher studies in physics. He then changed his field to biology at the University of California. He moved to MRC Laboratory of Molecular Biology, Cambridge. It was there he cracked the complex functions and structures of Ribosome, which fetched him Nobel Prize for Chemistry in 2009, along with Thomas E Steitz and Ada E Yonath. Venkataraman Ramakrishnan began his career as a postdoctoral fellow with Peter Moore at Yale University, where he worked on ribosome. At the Medical Research Council Laboratory of Molecular Biology, he began a detailed research on ribosomes. InVenkataraman earned a fellowship from the Trinity College, Cambridge and the Royal Society. He is also an honorary member of the US National Academy of Sciences. In 2007, he was awarded with the Louis-Jeantet Prize for his contribution to Medicine. In 2008, he was presented with Heatley Medal of British Biochemistry Society. For his contribution to Science, he was conferred with India's second highest civilian award, the Padma Vibhushan in 2010.

Vijay P Bhatkar

Dr Vijay Pandurang Bhatkar is best known as the architect of India's first supercomputer 'Param' and as the founder Executive Director of C-DAC, India's national initiative in supercomputing. He is credited with the creation of several national institutions, notably amongst them being C-DAC, ER&DC, IIITM-K, I2IT, ETH Research Lab, MKCL and India International Multiversity. As the architect of India's PARAM series of Supercomputers, Dr Bhatkar has given India GIST multilingual technology and a lot of other path-breaking initiatives. Born on October 11, 1946 at Muramba, Akola, Maharashtra, Bhatkar obtained his Bachelor of Engineering degree from VNIT Nagpur in 1965. This was followed by masters from MS University, Baroda and a PhD in Engineering from IIT Delhi, in 1972. He has been a Member of Scientific Advisory Committee to Cabinet of Government of India, Governing Council Member of CSIR, India and eGovernace Committee Chairman of Governments of Maharashtra and Goa. A Fellow of IEEE, ACM, CSI, INAE and leading scientific, engineering and professional societies of India, he has been honoured with Padmashri and Maharashtra Bhushan awards. Other recognitions include Saint Dnyaneshwar World Peace Prize, Lokmanya Tilak Award, HK Firodia and Dataquest Lifetime Achievement Awards, and many others. He was a nominee for Petersburg Prize and is a Distinguished Alumni of IIT, Delhi. His current research interests include Exascale Supercomputing, AI, Brain-Mind-Consciousness, and Synthesis of Science and Spirituality. He is presently the Chancellor of India International Multiversity, Chairman of ETH Research Lab, Chief Mentor of I2IT, Chairman of the Board of Unnath Bharat Abhiyan, Chairperson of Oversight Commitee at Scence & Engineering Research Board. He is also the National President of Vijnana Bharati.

ANCIENT ARABIAN SCIENTISTS



Abbas Ibn Firnas

Abbas Ibn Firnas (810-887) was polymath—an inventor, physician, engineer, musician and poet. He is also also known as Abbas Abu Al-Qasim Ibn Firnas Ibn Wirdas al-Takurini.   He was born in Izn-Rand Onda, Al-Andalus (today's Ronda, Spain). He lived in Emirate of Cordoba.

He devised a chain of rings that enabled to simulate the motions of the planets and stars and a means of manufacturing colourless ; designed a water clock called Al-Maqata; invented various glass planispheres; and made corrective lenses.

He also developed a process for cutting rock crystals. Apparently he had designed a room in his house in which spectators could witness stars, clouds, thunder, and lightning.

Al Idrisi

Abu Abd Allah Muhammad al-Idrisi al-Hasani al-Sabti or simply Al Idrisi (1099–1165 or 1166) was born in the city of Ceuta then belonging to Moroccan Almoravids. He lived Sicily and served in the court of King Roger II. He was a geographer, cartographer, and Egyptologist. Al-Idrisi is best known for his map, Tabula Rogeriana. It was prepared for King Roger II. Al-Idrisi's work exerted strong influence on geographers like Ibn Battuta, Ibn Khaldum and Piri Reis. He also inspired Christopher Columbus and Vasco Da Gama.

Al Battani

Abu Abd Allah Muhammad ibn Jabir ibn Sinan al-Raqqi al-Harrani al-Sabi al-Battani (c.858-c.929) was born in Harran near Urfa in Upper Mesopoamia (now in Turkey). He lived and worked in the city of Ar-Raqqah in north central Syria. In Latin literature he is referred to as Albategnius, Albategni or Albatenius. He was an astronomer, astrologer and mathematician. He extended a number of trigonometric relations which were transmitted from India and Greco-Rome. His book, Kitab az-Zij was frequently quoted by many medieval European astronomers including by Copernicus.

Alhazen

Abu al-Hasan ibn al-Hasan al-Haytham (c. 965-c. 1040), often referred to as ibn al-Haytham was an Arab polymath. He is also known as by his Latinised name Alhazen or Alhacen. He was born in Basra, then part of Buyid emirate. He lived mainly in Cairo, Egypt. He made significant contributions to the priciples of optics, astronomy, mathematics, meteorology, visual perception and scientific method. He is regarded as father of modern optics, ophthalmology, experimental physics and scientific methodology. He is also regarded as the first theoretical physicist. In medieval Europe, he was nicknamed Ptolemaeus Secundus ("Ptolemy the Second")] or simply called "The Physicist". Alhazen made significant improvements in optics, physical science, and the scientific method. Alhazen's work on optics is credited with contributing a new emphasis on experiment.Jim Al-Khalili, a British-Iraqi terms Alhazen as be the "first true scientist" based on Alhazen's pioneering work on scientific method.

Abu al-Qasim Khalaf ibn al-Abbas Al-Zahrawi

Abu al-Qasim Khalaf ibn al-Abbas Al-Zahrawi (936–1013), was an Arab Muslim physician. He is also known as Albucasis. He was born in the city El-Zahra, Andalusia. He lived most of his life in Córdoba. He is considered the greatest medieval surgeon. Many regard him as the father of modern surgery. His greates work on medicine was a thirty-volume encyclopedia of medical practices titled Kitan al-Tasrif. He made pioneering contributions to the field of surgical procedures and instruments and some of his discoveries are still applied in medicine to this day. He was the first physician to describe an ectotopic pregnancy. He was also first to identify the hereditary nature of haemophilia. He was the first to draw hooks with a double tip for use in surgery. He illustrated various cannuale for the first time and treated wart with an iron and caustic metal as a boring instrument.

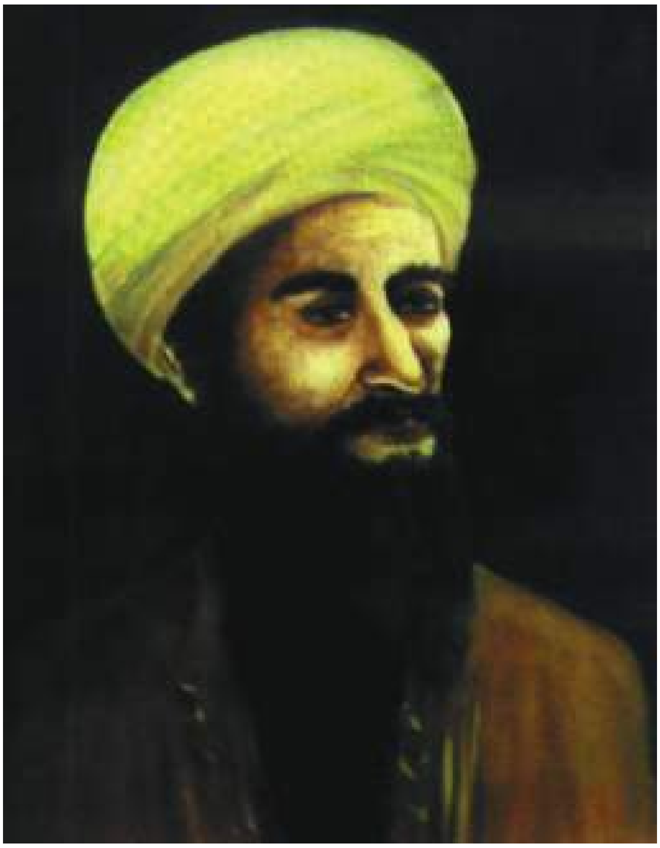
Abu Ishak Ibrahim ibn Yahya al-Naqqash al-Zarqali

Abu Ishak Ibrahim ibn Yahya al-Naqqash al-Zarqali (1029-1087) was one of the leading astronomers of his time. He was also an instrument maker and astrologer. Although he is usually called as al-Zarqālī but his correct name was al-Zaqalluh. In Latin he is referred to as Arzachel or Arsechieles. He was born in born in a village near the outskirts of Toledo, then the capital of the Taifa of Toledo. He was trained as metalsmith.

He was well-versed in geometry and astronomy. In fact he was the one of the foremost astronomers of his time. He was an inventor and his works helped Toledo to become an intellectual centre of Al-andalus. He is also referred to in the works of Chaucer, as 'Arsechieles'.

Al-Zarqali's works were translated into Latin in the 12th century.

Abu Musa Jabir ibn Hayyan



Abu Mūsā Jābir ibn Hayyān (fl.c.721–c.815) was a prominent Muslim polymath. In Europe, Jabir was known as Geber (Latinised version of Jabir).He has been entitled differently as al-Azdi al-barigi or al-Kufi or al-Tusi or al-Sufi. An anonymous European writer produced alchemical and metallurgical writings under the pen-name 'Geber' (referred to as pseudo-Geber) in the 13th century. It is generally believed that Jabir was born in Tus, Khorasan in Iran (then Persia) and later moved to Kufa. However, some suggest that he was of Syrian origin and later lived in Persia and Iraq.

The seeds of the modern classification of elements into metals and non-metals could be seen in Jabir's chemical classification where he proposed the following three categories:

- "Spirits" which vaporise on heating, like camphor, sulphur and ammonium chloride.
- "Metals" like gold, silver, lead, tin copper and iron and khar-sini (Chinese iron).
- Non-malleable substances that can be converted into powders such as stones.

He made use of over twenty types of now-basic chemical laboratory equipment, such as the alembic and retort, and described many chemical processes like crystallisation and distillation. He described many substances like citric acid, acetic acid, tartaric acid, arsenic, antimony, bismuth, sulphur and mercury.

Jabir was a foremost alchemist of his time. He paved the way for most of the later Muslim alchemists, who lived in the 9th–13th centuries. As Max Meyerhoff observed Jabir's influence may also be traced throughout the entire historic course of European alchemy and chemistry. Jabir's treatises on alchemy were translated into Latin and became standard texts for European alchemists. In fact according to Erick John Holmyard, a historian of chemistry, Jabir developed alchemy into an experimental science and his influence is equal to that of Robert Boyle and Antoine Lavoisier.

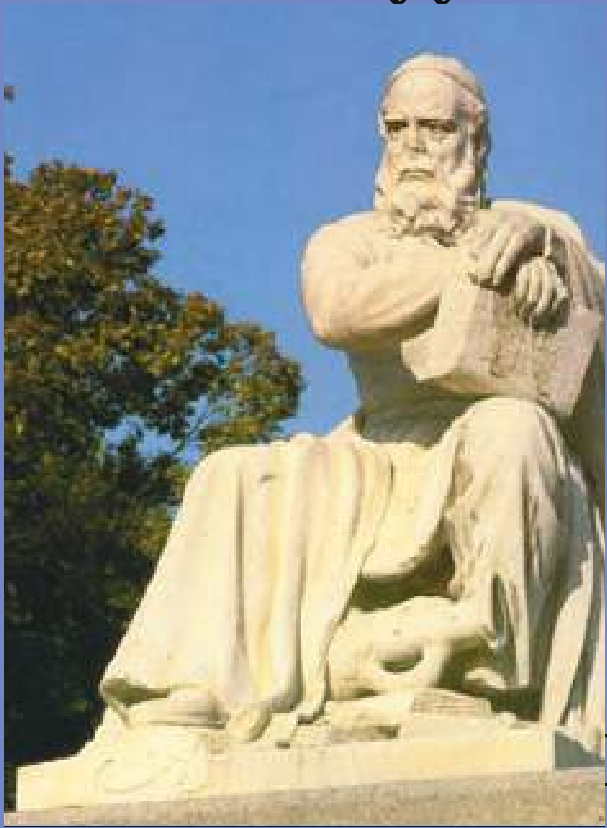
Ibn al-Nafis

Ala-al-din abu Al-Hassan Ali ibn Abi-Hazm al-Qarshi al-Dimashqi,(1231-1288) was an Arab physician. He is also called Ibn al-Nafis. He was born in Damascus. He is mostly known for being the first to describe the pulmonary circulation of the blood. He made original contributions to ophthalmology. His book Kitab al-Mukhtarfi al-Aghdhiya describes his studies on the effects of diet on health. He was an expert on the Shafi School of jurisprudence. He planned a 300-volume encyclopedia titled Al-Shamil fi al-Tibb but he could not complete it.

Al-Sabi Thabit ibn Qurra al-Harrani

Al-Sabi Thabit ibn Qurra al-Harrani (826-901) lived in Baghdad. He was born in Harran in Higher Mesopotamia/Assyria (Modern-day Turkey). He was a mathematician, physician, astronomer and translator. He made significant contributions to algebra, geometry, and astronomy. He was one of the first persons to reform the Ptolemaic system. He published his own observations of the Sun. He is regarded as a founder of statics in mechanics. Among his discoveries in mathematics was an equation for determining amicable numbers. He transformed mathematics by introducing the use of numbers to describe the ratios between geometrical quantities.

Omar Khayyam



Ghiyath ad-Din Abu'l Fath Umar ibn Ibrahim al-Khayyam Nishapuri (1048 – 1131) was one of the major mathematicians and astronomers of the medieval period. He is popularly known Omar Khayyam. He was born in Nishapur in North Eastern Iran. After studying at Samarkand he moved Bukhara. He was a polymath—philosopher, mathematician, astronomer and poet. He also studied mechanics, geography, mineralogy, music and Islamic theology.

Hunayn ibn Ishaq

Hunayn ibn Ishaq (809–873) was a famous scholar, physician and scientist. He was born in al-Hira in southern Iraq and worked in Baghdad. He is sometimes referred to as Hunain or Hunein. He is known for his translation of Greek scientific and medical works into Arabic and Syriac. He translated 116 works including Plato's Timaeus, Aristotle's Metaphysics and the Old Testament into Syriac and Arabic. Among the Arabs he was call "Sheikh of the translators". His method of translation was followed by later translators. Ḥunayn ibn Isḥaq was the most productive translator of Greek medical and scientific treatises in his day. He studied Greek and became known among the Arabs as the "Sheikh of the translators." He mastered four languages: Arabic, Syriac, Greek and Persian. His translations did not require corrections. Hunayn's method was widely followed by later translators. He himself wrote about 26 original treatises most of which were related to medicine. Hunayn ibn Ishaq enriched the field of ophthalmology. His developments in the study of the human eye can be traced through his innovative book, "Ten Treatises on Ophthalmology."

Ibn Sina

Ibn Sina (c. 980 – 1037) also known as Pur Sina or Abu Ali al-Husayn ibn Abd Allah ibn Al-Hasanibn Ali ibn Sina. Ibn Sina, whose Latinised name is Avicenna, was a Persian polymath. Regarded as the most famous and influential polymath of Golden Age, Ibn Sina wrote on mathematics, physics, medicine, philosophy, astronomy, alchemy, geology, psychology, logic, theology and poetry.

Tusi

Khawaja Muhammad ibn Muhammad ibn Hasan Tūsī (1201– 1274) was born in the city of Tus in mediaval Khorasan (in north-eastern Iran). In the west he is usually known as Nasir al-Din or simply as Tusi. He was a plymath---astromer, biologist, chemist, mathematician, philosopher, physician, physicist and theologian.

Tusi is considered as one of the most eminent astronomers of his time. Based on his observations made at Rasad Khaneh Observatory Tusi made very accurate tables of planetary movements and which were presented in his book Zij –I ilkhani (Ilkhanic Tables) . This book contains astronomical tables for calculating the positions of the planets and the names of the stars. The model for the planetary system developed by Tusi was the most advanced of his time. It was used extensively until the development of the heliocentric model. For preparing his planetary models he introduced a geometrical technique called Tusi-couple.

Tusi proposed a theory of evolution of species in his book, Akhlaq-i-Nasri. He discussed how organisma were able to adapt to their environment. He recognized three types of living things: plants, animals, and humans and attempted to explain how humans evolved from advanced animals.

Mohhammad ibn Zakariya al-Razi

Mohhammad ibn Zakariya al-Razi (854-925/935), in Latin he is known as Rhazes or Rasis. He was a plymath—physician, alchemist, chemist and philosopher. He occupies an important place in history of medicine. He is regarded as the discoverer of alcohol and vitriol (sulphuric acid).

Rhazes made fundamental contributions to various fields of science. He wrote over 200 manuscripts. He is known for his contribution which led to numerous advances. He was an early advocate of experimental medicine. He was one of the first persons to use Humoralism to distinguish one contagious disease from another. He is regarded as the father of paediatrics and a pioneer of ophthalmology.

Muhammad ibn Musa al-Khwarizmi

Muhammad ibn Musa al-Khwarizmi (c.780-c.850) was a mathematician, astronomer and geographer. He has also been mentioned in Latin literature as Algoritmi or Algaurizin. He was bron in a Persian family, probably in Chorasmia. It has been argued by D. M. Dunlop that Muḥammad ibn Mūsā al-Khwārizmī was in fact the same person as Muhammad ibn Shakir, the eldest of the three Banu Musa.

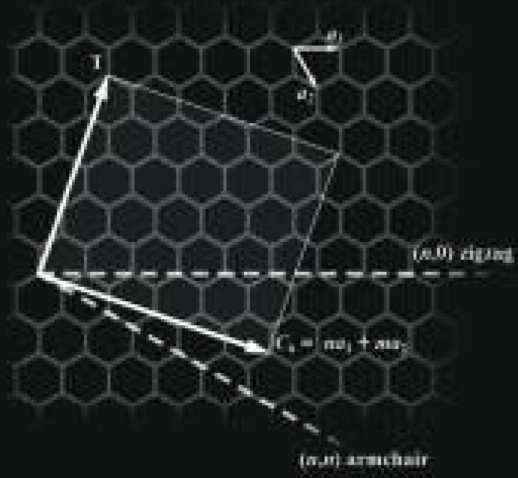
He presented the first systematic solution of linear and quadratic equations in Arabic in his treatise, Compendious Book on Calculation by Completion and balancing. He is regarded as inventor of algebra. It was his systematic approach to solving linear and quadratic equations that led to algebra. The word 'algebra' is derived from 'al-jabr', one of the two operations he used to solve quadratic equation.

He revised Ptolemy's Geography. He also wrote on mechanical devices like astrolabe and sundial. The words 'algorism' and 'algorithm' stem from the Latin version of his name Algoritmi. He took part in a project to determine the circumference of the Earth and and in making a world map for al-Mamun, the caliph.

ANCIENT INDIAN SCIENCES

NANOTECHNOLOGY

IN METTALLURGY



Carbon nanotubes, first announced by Russian scientists in 1952, was found in the sword of Tipu Sultan as well as in Damascus Steel. Carbon nanotubes which are cylidrical fullerenes have extraordinary strength in terms of tensile strength and elastic modulus.

The Damascus steel/ Wootz steel as it is known is formed by adding large quantities of carbon to iron and this steel industry was based in the southern peninsula. The name Wootz is the westernized version of Kannada ukku and Sangam Tamil ekku, meaning crucible steel.

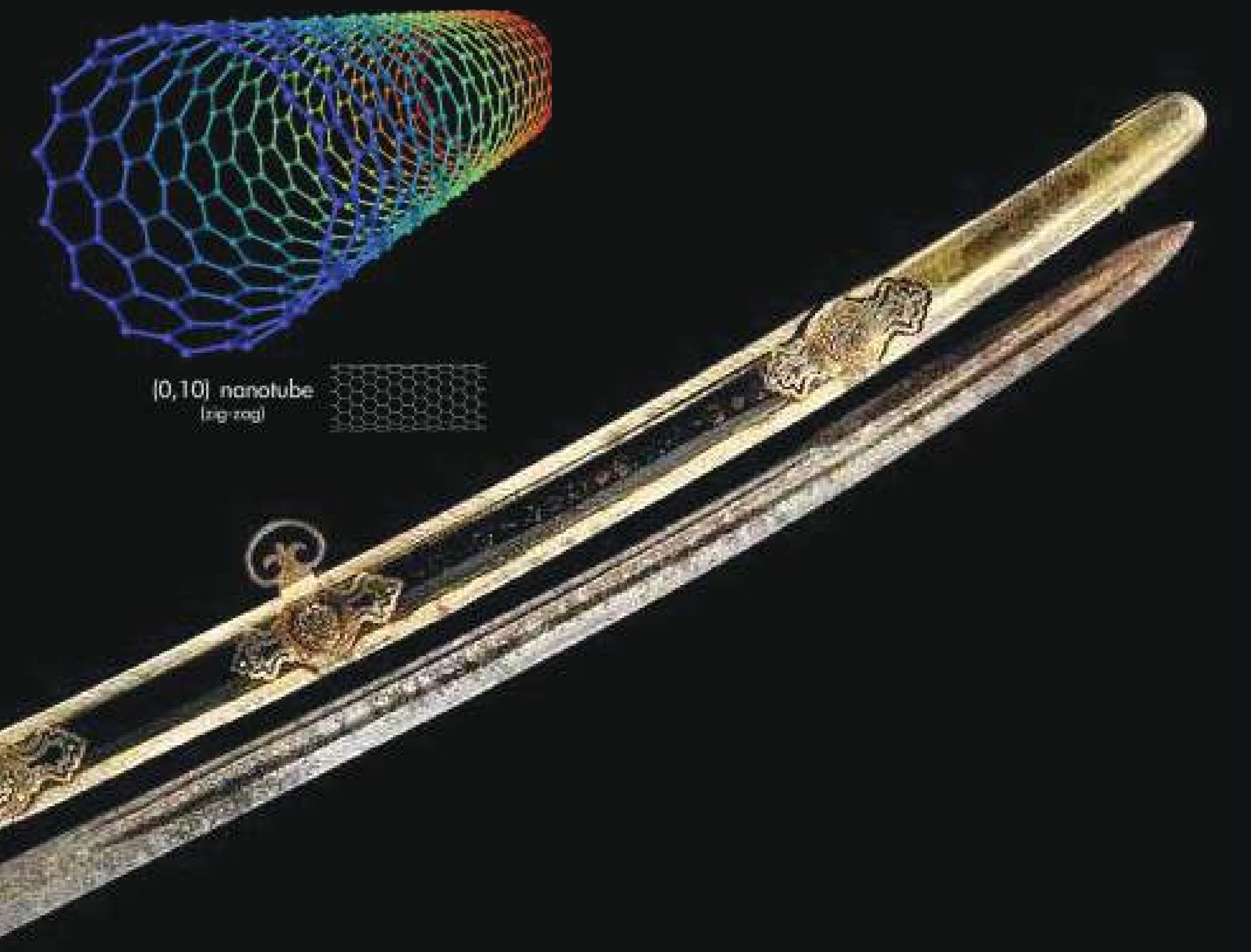
Peter Paufer and colleagues in Germany examined samples of Damascus steel with high resolution electron microscopy and found carbon nanotubes and cementite nanowires.

A discovery reported online by Nature on 16 November 2006 is that those engineers in India two millennia ago did nanotechnology in developing a technique to create nanotubes that may be protecting the nanowires of cementite. With the help of just the right mix of trace elements that helped the process in the specific ores that were used.

“Our ancestors have been unwittingly using the technology for over 2,000 years and carbon nano for about 500 years. Carbon nanotechnology is much older than carbon nanoscience,” said Robert Floyd Curl, Jr., Nobel Prize Winner in Chemistry in 1996, at the 95th Indian Science Congress.

Indian craftsmen used unique smelting techniques to manufacture the Damascus blades which led to nanotisation giving them a unique long-lasting edge.

India, for ages, was a leading exporter of this steel which was used to make Persian daggers which were quite popular in Europe centuries ago.



The Sword of Tipu Sultan is one of the many examples exhibiting nano particle re-enforcement for higher strength and quality

NANOTECHNOLOGY

IN MEDICINE

The Metals and Minerals are heavy, nonabsorbable and toxic substances. Metals are used as medicines in Ayurveda since from Samhita period (600to1000 BC) in the fine powder form

named as Ayaskriti. Latter with the development of Marana technique (7th Cent AD) the Metals and Minerals are converted in to very very fine and absorbable, therapeutically most effective and least or Nontoxic form of Medicines known as Bhasma .

According to Ayurvedic concept the change in the qualities is due to Samskara done through Shodhana, Bhavana, Putapaka procedures by which particle size of Metals and Minerals are reduced to finer and finer form of Bhasma.

The Bhasma particles when analysed microscopically through SEM (Scanning Electron Microscopy) and TEM (Tunnelling Electron Microscopy) fall under the range of Nanoparticles of contemporary science.

The minerals and metals in their gross form are not at all useful as medicine, but when their form changes from macro to microscopic form (Bhasma) they exhibit wide range of therapeutic properties.
If we observe the different stages in the preparation of Bhasma it can be noted that at every stage effort is made to bring down the particle size finer and finer.
In developing nano medicine and for targeted drug delivery and other utilities of modern nano technology applications in healthcare, current technological development may be accelerated by incorporating the ancient wisdoms.

NANOTECHNOLOGY
IN ARTS

According to Robert Floyd Curl, Jr., Nobel Prize Winner in Chemistry in 1996, Indian craftsmen used nanotechnology in Wootz steel as well as in paintings. Ajanta paintings, traditional Indian cosmetic

Kajal all serve as examples showing the technological understanding of nanotechnology apart from macro sciences by ancient scientists.

In Ajanta paintings, one studies have found presence of carbon nanotubes which are believed to have been utilized for longer lasting impressions. Chemistry professor Sabyasachi Sarkar has been able to extract up to 40 percent carbon nanotubes from kajal, as well as render the nanotubes water-soluble by treating them with nitric acid.

MEDICINE

Subject -Centric Medicine

Ayurveda has integrated the concept of interconnectedness into its understanding of health and disease. It considers the human body as an indivisible whole with a network of interrelated functions, mind and consciousness, wherein a disturbance in one part will have repercussions in other parts as well. The key to health is for these factors to maintain stability since disease is seen as a perturbation in this network. Ayurvedic treatment aims not only at removal of disease, but also at the restoration of the equilibrium of bodily functions. The centuries-old science of Ayurveda, apart from being a holistic form of medicine, also clearly defines the student-teacher and doctor-patient relationship. It sets high ethical standards of professional and personal integrity for the doctor, teacher and student. In addition to being technically skilled and well-read in the science, practitioners of Ayurveda must be compassionate and empathetic. Students of Ayurveda are taught the importance of compassionate caring for patients and maintaining personal integrity.

Ayurveda considers the human being as a combination of two basic elements: consciousness (chetana) and inert matter (jada). The relationship between these two entities makes a human being. The realms within, therefore, consist of not only the physical and physiological aspects, but also the mind and subtler levels of awareness/consciousness. Ayurveda connects these realms and adopts a comprehensive view of life and health. It says that the subtler levels within influence the physiology.

The doctor-patient relationship is an important part of medical care and more so in the current health scenario where an increasing number of health problems are considered psychosomatic in nature, or diet and lifestyle-related. In Ayurveda, the doctor is considered not only as a healer, but also a friend and philosopher, and is expected to preserve a high level of professional and personal integrity to be in a position to advise patients. The doctor is constantly reminded that this noble profession is for the welfare of the patient and not for making money. The relationship between the physician and the patient is considered a key factor for the well being and recovery of the patient . Clinical empathy is considered an essential interpersonal skill required for professional competency, success and the patient's well being.

The doctor, in addition to being knowledgeable and technically skilled, is expected to maintain good qualities such as being compassionate, empathetic, caring and kind to all patients. They are asked to nurture cordial feelings towards their patients like a mother, father, or brother. The quality of compassion is highly valued and applied not only to patients but to all sentient life. This is an essential requirement for an Ayurvedic physician and forms an important part of medical ethics. Interestingly, truth is not to be viewed in isolation in Ayurveda. If it is likely to harm the patient, then compassion has to overrule this virtue. Likewise, if a lie can do good to the patient, it is to be condoned.

MEDICINE

Yoga

Yoga is essentially a spiritual discipline based on an extremely subtle science, which focuses on bringing harmony between mind and body. It is an art and scince of healthy living. The word 'Yoga' is derived from the Sanskrit root 'Yuj', meaning 'to join' or 'to yoke' or 'to unite'. According to which human beings can realize this union and achieve mastery over their destiny. The development of yoga can be traced back to over 5,000 years ago, but some researchers think that yoga may be up to 10,000 years old old. Yoga's long rich history can be divided into four main periods of innovation, These different Philosophies, Traditions, lineages and Guru-shishya paramparas of Yoga lead to the emergence of differnt Traditional Schools of Yoga e.g. Jnana-yoga, Bhakti-yoga, Karma-yoga, Dhyana-yoga, Patanjala-yoga, Kundalini-yoga, Hatha-yoga, Mantra-

modern scientists, everything in the universe is just a manifestation of the same quantum firmament. One who experiences this oneness of existence is said to be in yoga, and is termed as a yogi, having attained to a state of freedom referred to as mukti, nirvana or moksha. Thus the aim of Yoga is Self-realization, to overcome all kinds of sufferings leading to 'the state of liberation' (Moksha) or 'freedom' (Kaivalya). Living with freedom in all walks of life, health and harmony shall be the main objectives of Yoga practice."Yoga" also refers to an inner science comprising of a variety of methods through practice and development. Yoga, being widely considered as an 'immortal cultural outcome' of Indus Saraswati Valley civilization – dating back to 2700 B.C., has proved itself catering to both material and spiritual upliftment of humanity.

For many, the practice of yoga is restricted to Hatha Yoga and Asanas (postures). However, among the Yoga Sutras, just three sutrasare dedicated to asanas. fundamentally, hatha yoga is a preparatory process so that the body can sustain higher levels of energy. The process begins with the body, then the breath, the mind, and the inner self.

Traditional Schools of Yoga : yoga, Laya-yoga, Raja-yoga, Jain-yoga, Bouddha-yoga etc. Each school has its own principles and practices leading to altimate aim and objectives of Yoga. Yogic Practices for Health and Wellness:The widely practiced Yoga Sadhanas (Practices) are: Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana (Meditation), Samadhi / Samyama, Bandhas & Mudras, Shat-karmas, Yukta-ahara, Yukta karma, Mantra japa, etc.Yama's are restraints and Niyama's are observances. These are considered to be pre-requisits for the Yoga Sadhanas (Practices).

MEDICINE

Umbilical Cord Banking

Texts on social theory such as the Laws of Manu ("Mānavadharmaāstra") prescribe birth rituals, such as the jatakarma. It also states that the ritual must take place before the umbilical cord is severed & on how it is stored and reused.

However, all the ritualistic details are no longer available. It was only in the year 1978, that a discovery regarding stem cells was made in the modern world. The ritualistic practice of Jatakarma is still in practice in some parts of central and North-Western India.

MEDICINE

Plastic Surgery

Plastic surgery seems to be an invention of the modern age. The desire to attain physical beauty is no doubt one of the factors that has contributed to the popularity of this procedure. Apart from cosmetic reasons, plastic surgery is also carried out for reconstructive purposes. Yet, plastic surgery has been around longer than most people realize. One of the earliest instances of plastic surgery can be found in the *Sushruta Samhita*, an important medical text from India. The *Sushruta Samhita* is commonly dated to the 6th century B.C., and is attributed to the physician Sushruta (meaning 'very famous' in Sanskrit). The *Sushruta Samhita*'s most well-known contribution to plastic surgery is the reconstruction of the nose, known also as rhinoplasty.

Atharva Veda, the root of Ayurveda , the classical text of Indian medical knowledge includes two seminal texts, Charaka Samhita on medicinal aspects and Sushruta Samhita which incorporates details of surgical tools and operative techniques. Sushruta wrote this treatise based on the lectures of his teacher, the famous surgeon king, Devadas ('incarnation of Dhanwantari , the divine physician). In fourth century A.D. Vagbhat , an Indian

The process of Rhinoplasty is described as such:

"

The portion of the nose to be covered should be first measured with a leaf. Then a piece of skin of the required size should be dissected from the living skin of the cheek, and turned back to cover the nose, keeping a small pedicle attached to the cheek. The part of the nose to which the skin is to be attached should be made raw by cutting the nasal stump with a knife. The physician then should place the skin on the nose and stitch the two parts swiftly, keeping the skin properly elevated by inserting two tubes of eranda (the castor-oil plant) in the position of the nostrils, so that the new nose gets proper shape. The skin thus properly adjusted, it should then be sprinkled with a powder of licorice, red sandal-wood and barberry plant. Finally, it should be covered with cotton, and clean sesame oil should be constantly applied. When the skin has united and granulated, if the nose is too short or too long, the middle of the flap should be divided and an endeavor made to enlarge or shorten it. "

physician recounted the plastic surgical procedures with more details than provided in Sushruta Samhita. In his book,'Ashtanga Hridyans Samhita' he credits the techniques to Maharishi Atreya. It is interesting to find mention of plastic surgical procedures such as rhinoplasty, otoplasty, tissue grafting, organ transplants, transfer of embryo, cross-grafting of head and re-attachment of limbs etc. in these ancient Indian Medical Treatises and Puranic Literature.

During the 8th century A.D., the Sushruta Samhita was translated into Arabic by a person known as Ibn Abillsaibial. Nevertheless, European mastery of plastic surgery, and surgery in general, only came several centuries later. Meanwhile, in India the Suhruta Samhita has made Indian physicians highly skilled in surgical practice.

COSMOLOGY

Calendars

The Indian calendar has five (pancha) limbs (anga), concerning five elements of time division. These are: va ra, tithi, nakshtra, yoga and krana.

These are defined as follows:
Vara: It is the name of the day like Monday (Somavar), Tuesday (Mangalvar) etc.
Tithi: The moment of new Moon, or that point of time when the longitudes of Sun and Moon are equal is called 'amavasya'. The tithi is the time taken by the Moon in increasing its distance from the Sun by 12 degrees. The complete revolution of the Moon (29.5 days) occupies 30 tithis for 360 degrees. Since the motions of the Sun and Moon are always varying in speed the length of a tithi constantly alters.

Nakshatra: The time, which the Moon requires to travel over the 27th part of the ecliptic, is called 'nakshatra'. During the traversal of Moon around the Earth it was noticed that the Moon is close to some of the fixed heavenly bodies (stars). Twenty-seven stars that fall on the path of the Moon identified. In 29.5 days, that is, Moon's one synodic revolution, Moon travels through 27 stars that were said to form the 27 Nakshatras. Hence, on an average Moon travels one nakshatra everyday. The star, which is closest to the Moon on its path, is called Moon's Nakshatra.

Yoga: The period of time during which the distance between the Sun and Moon is increased by 13° 20′. This is about 1 day.
Karana: The karana is half the tithi or during which the difference of the longitudes of Sun and Moon is increased by 6°.
While the first three units are still in use, Karanas and Yogas are hardly used in day-to-day life.

Astronomy

Surya Siddhanta

Surya Siddhanta is the first among the traditions or doctrines (siddhanta) in archaeo-astronomy of the Vedic era. Infact, it is the oldest ever book in world which describes earth as sphere but not flat, gravity being reason for objects falling on earth etc. Going by calculations of Yugas, first version of Surya Siddhanta must have been known around 2 million years ago. However, the present version available is believed to be more than 2500 years old, which still makes it the oldest book on earth in Astronomy.

Utpala, a 10th-century commentator of Varahamihira, quotes six shlokas of the Surya Siddhanta of his day, not one of which is to be found in the text now known as the Surya Siddhanta. The present version was modified by Bhaskaracharya during the Middle Ages. The present Surya Siddhanta may nevertheless be considered a direct descendant of the text available to Varahamihira (who lived between 505–587 CE)

Ancient Indians had shown great proficiency in astronomy since Vedic times. Aryabhata described his astronomical ideas in his celebrated treatise Aryabhatiya (also called Arybhatiyam). This work laid the foundation of Aryabhata Siddhantic School of Astronomy. Aryabhata is one of the most important figures in history of India's astronomy. Commenting on the status of Indian astronomy at the time of Aryabhata, M. L. Sharma of the Sampurananda Sanskrit University, wrote: "…at the time of

Aryabhata, Indian astronomy had reached the state of development where it possessed all mathematical, astronomical and instrumental knowledge which was ideal for the higher study of astronomy. To reach that state of development a lot of time was needed. So the beginning of Siddhanta astronomy in India must have taken place much earlier than it is usually supposed. It may be said that Indian astronomy was facing problem also at the time. In this background of astronomical knowledge we enter the period of Aryabhata."

Aryabhata was the first Indian astronomer to propose the rotation of Earth to explain the daily westward motion of the stars in the sky. He stated that rising and setting of the Sun, the Moon and other heavenly bodies are due to the relative motion caused by the Earth's rotation about its axis once a day. He introduced many new concepts such as an alphabetical system of expressing numbers, rules for extraction of squares and cube roots, construction of trigonometric sine tables and eccentric-epicentric model of planetary motion. He worked out the value of pi as 3.1416 for the first time in India, which is correct to the first four decimal places. He knew that the value given by him was 'asanna', that is, approximate. This is because pi is irrational or incommensurate. He also believed that eclipses were caused by the shadows Moon and the Earth and not by Rahu-Ketu as it was believed. Ayabhata was aware of the spherical shape of the Earth.

Almost nothing is known about his life. His name is sometime spelled as 'Aryabhatta'. It may be noted there is another astronomer of the name Aryabhata who lived in tenth century AD. To distinguish the two, they are called Aryabhata I and Aryabhata II (c. 950). Aryabhata II was basically a compiler and he was adherent to orthodox views. Arabic scholars referred to Aryabhata as arjbhar or ajabhar. Abu Raihan Muhammad ibn Ahmad Al-Biruni (973-1048) (usually referred to simply as Al-Biruni) wrote: "They (Alfazari and Y'kub) apparently did not understand him and imagined that Arybhata means a 'thousand part'". Al-Biruni, a mathematician and astronomer of some repute came to India in the eleventh century. He travelled to India during 1017 and 1030 as a political hostage with Mahmud of Ghazni, the first Sultan of the Ghaznavi dynasty in Afghanistan, in the course of the latter's invasion of India.

Earlier scholars thought that Aryabhata was either born in Kusumpura, a suburb of Pataliputra (modern-day Patna) or taught there. Some scholars identified Kusumpura with Pataliputra. Aryabhata himself in one the verses of Ganitapada stated: "…he (Aryabhata) sets forth in his work the science which is held in high esteem at Kusumpura." However, recent studies on the works of Bhaskara, the greatest exponent of Aryabhata's system of astronomy and other medieval commentators of Aryabhata, reveal that earlier held belief is not correct. In these works, Aryabhata is often referred to as 'asmaka' that is one who comes from Asmaka region located in southern India, possibly in modern-day Kerala, and his work Asmaka sphutatantra. Another fact which supports the view that Aryabhata came from Kerala is that most of the commentaries of Aryabhatiya and works based on it have come largely from southern India, especially from Kerala. Further, majority of the astronomers belonging to Aryabhata school come from South India.

Aryabhatia is written in verse couplets. It is a small work containing about 121 slokas or stanzas. It is divided into four sections called padas, namely, Gitikapada, Ganitapada, Kalakriyapada and Golapada.

The Gitikapada is the shortest of the four sections. It has 13 stanzas including the verses meant for dedication and conclusion. Out of the 13 stanzas 10 are in Gitika metre and that is why it is also known as

Dashagitika. “One who knows these verses, one who knows the movements of planets and nakstras, goes much beyond them and attains the Absolute Brahma”, says the author. In this section the basic definitions and important astronomical parameters and tables are given. It also explains the rules of a unique method of writing numbers in Sanskrit alphabets.
The remaining two sections Kalakriyapada and Golapada deal with astronomical principles and methods of computations in very condensed form.
The section Kalakriyapada (Kalakriya means reckoning of time) has 25 stanzas. It includes topics like ‘division of time and the circle, definitions of solar year, lunar month, civil day, sidereal day, intercalary months, omitted lunar days, planetary orders and movements, the eccentric-epicycle models, use of these models for the calculations of the true planetary positions from the Earth’ and other related topics.
The Golapada is the longest section and it is for this section Aryabhata is most famous. Gola means sphere. It has 50 stanzas. In this section Aryabhata explains the methods of representing planetary motions in a celestial sphere. He also defines such terms like prime vertical, meridian, horizon, hour circle, equator, parallax, and ecliptic. He discusses the pata (ascending nodes) of the planets and the shadow of the Earth movement on the path of the Sun (arka-apanamandala). Aryabhata asserts that the Earth is the centre of the universe and it revolves around its axis. In fact, Aryabhata was the first Indian astronomer to consider the rotation of the Earth for explaining the apparent daily motions of the fixed stars. But his idea did not find support among his contemporaries or later astronomers. It was not unexpected, as in those days the prevailing belief was that the Earth was not only at the centre of the universe but it was fixed.
The system of astronomy taught in Aryabhatia is usually referred to as the Audyayika system because the day beginning is reckoned from the mean sunrise (udya) at Sri Lanka, a place situated close to the Earth’s equator.
Aryabhata was also the originator of another system of astronomy called ardhratrika in which the day beginning is reckoned from the mean midnight (ardharatri) at Lanka (Sri Lanka). Varahamihira wrote: “Aryabhata maintains that the beginning of the day is to be reckoned from midnight at Lanka; and the same teacher again says that the day begins from sunrise at Lanka”. Brahmasphuta-siddhanta talks about these two systems of astronomy described by Aryabhata. Brahmagupta himself followed ardharatrika system.

Brahmagupta was an important astronomer in his own right. It may be noted that Brahmagupta’s attitude towards Aryabhata changed with time. The abovementioned highly critical remarks were written by him in, composed at the age of 30. However, his Khandakhadyaka, composed at the age of 67 was

The Indian Calendar , also known as Panchang

primarily based on Aryabhata's ardharatrika system. It may be noted that Brahmagupta's works were translated into Arabic by Muhammad ibn Ibrahim al-Fazari (died 796 or 800) Ya'qub ibn Tariq (died 796) as Sindhind (a translation of Brahmasphuta-siddhanta) and the Arakand (a translation of Khadakhadyaka).

Bhaskara introduced many new methods of his own. While Aryabhata postulated rules for indeterminate analysis, it was Bhaskara who elaborated it and its application to astronomy. Bhaskara prepared an abridged version of his main work known as Laghubhaskariya.

The first Indian-built satellite launched by a rocket of erstwhile Soviet Union in April 1975 was named after Aryabhata.

MATHEMATICS

Zero

The concept of zero as a digit in the decimal place value notation was developed in India, presumably as early as during the Gupta period (c. 5th century), with the oldest unambiguous evidence dating to the 7th century.

The Indian scholar Pingala (c. 200 BC) used binary numbers in the form of short and long syllables (the latter equal in length to two short syllables), a notation similar to Morse code.Pingala used the Sanskrit word śūnya explicitly to refer to zero.

The earliest text to use a decimal place-value system, including a zero, the Lokavibhāga, a Jain text surviving in a medieval Sanskrit translation of the Prakrit original, which is internally dated to AD 458 (Saka era 380).

The origin of the modern decimal-based place value notation can be traced to the Aryabhatiya (c. 500).

The rules governing the use of zero appeared for the first time in the Brahmasputha Siddhanta (7th century). This work considers not only zero, but negative numbers, and the algebraic rules for the elementary operations of arithmetic with such numbers. In some instances, his rules differ from the modern standard, specifically the definition of the value of zero divided by zero as zero.

Brahmagupta was the first to give rules to compute with zero. The texts composed by Brahmagupta were composed in elliptic verse in Sanskrit, as was common practice in Indian mathematics.

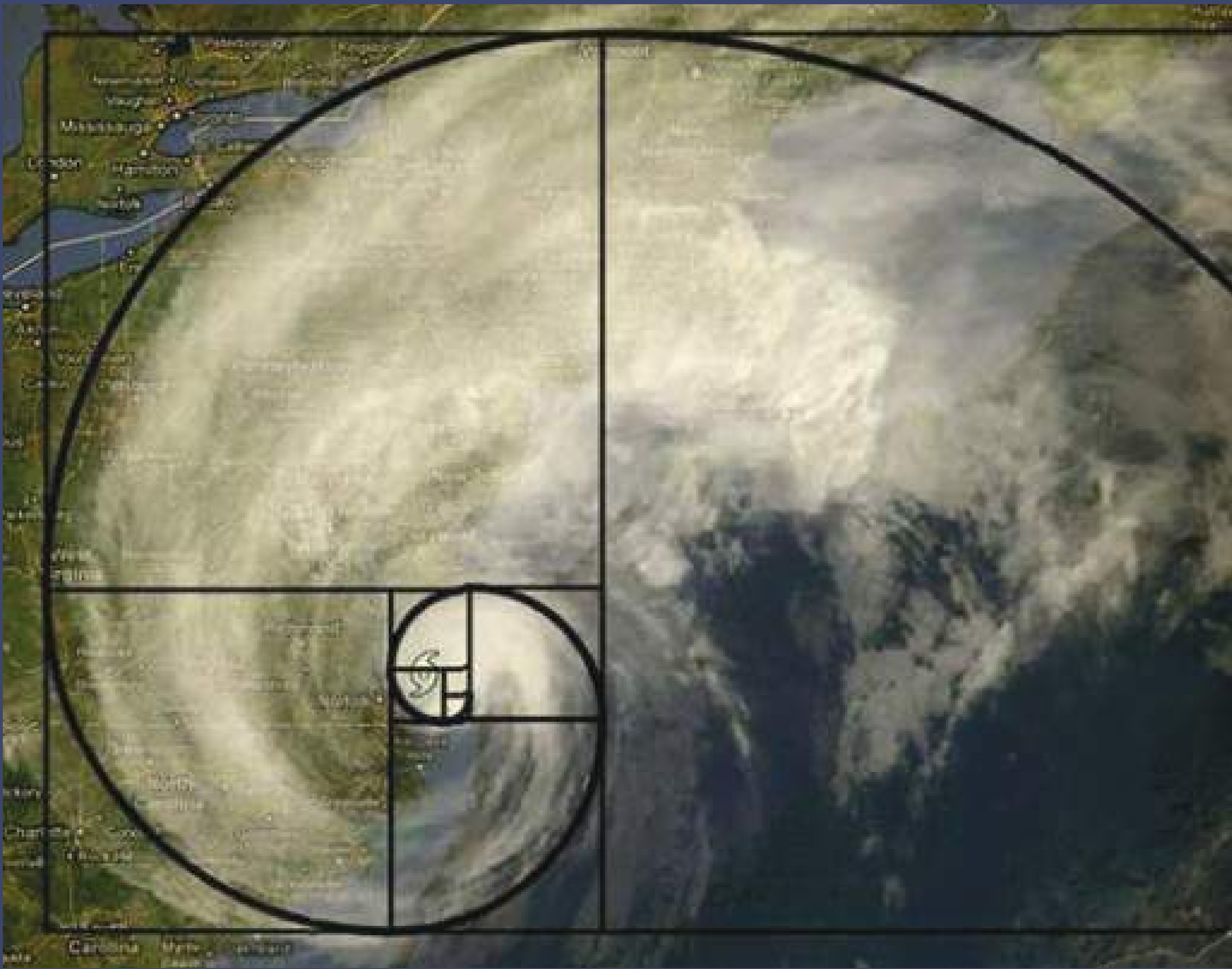
Hemachandra Numbers/ Fibonacci Sequence

The Fibonacci sequence appears in Indian mathematics, in connection with Sanskrit prosody. In the Sanskrit oral tradition, there was much emphasis on how long (L) syllables mix with the short (S), and counting the different patterns of L and S within a given fixed length results in the Fibonacci numbers; the number of patterns that are m short syllables long is the Fibonacci number Fm + 1. The Fibonacci sequence is named after Leonardo of Pisa, who was known as Fibonacci. Fibonacci's 1202 book Liber Abaci introduced the sequence to Western European mathematics. (By modern convention, the sequence begins with F0 = 0. The Liber Abaci began the sequence with F1 = 1, omitting the initial 0, and the sequence is still written this way by some.)

Among the scholars of the post-Vedic period who contributed to mathematics, the most notable is Pingala (piṅgalá) (fl. 300–200 BCE),a musical theorist who authored the Chhandas Shastra (chandaḥ-śāstra, also Chhandas Sutra chhandaḥ-sūtra), a Sanskrit treatise on prosody.

There is evidence that in his work on the enumeration of syllabic combinations, Pingala stumbled upon both the Pascal triangle and Binomial coefficients, although he did not have knowledge of the Binomial theorem itself. Pingala's work also contains the basic ideas of Fibonacci numbers (called maatraameru). Although the Chandah sutra hasn't survived in its entirety, a 10th-century commentary on it by Halāyudha has.

Fibonacci considers the growth of an idealized (biologically unrealistic) rabbit population, assuming that: a newly born pair of rabbits, one male, one female, are put in a field; rabbits are able to mate at the age of one month so that at the end of its second month a female



Formations of accurate fibonnacci representation , can be observed everywhere in nature, even in storm & hurricanne patterns.

can produce another pair of rabbits; rabbits never die and a mating pair always produces one new pair (one male, one female) every month from the second month on. The puzzle that Fibonacci posed was: how many pairs will there be in one year? What are generally referred to as the Fibonacci numbers and the method for their formation were given by Virahaṅka (between a.d. 600 and 800), Gopala (prior to a.d. 1135) and Hemacandra (c. a.d. 1150), all prior to L. Fibonacci (c. a.d. 1202). Narayaṅna Paṅḋita (a.d. 1356) established a relation between his smasika-paṅkti, which contains Fibonacci numbers as a particular case, and “the multinomial coefficients

MATHEMATICS
ALGEBRA

In India around the 5th century A.D. a sys tem of mathematics that made astronomical calculations easy was developed. In those times its application was limited to astronomy as its pioneers were Astronomers. As tronomical calculations are complex and involve many variables that go into the derivation of unknown quantities. Algebra is a short-hand method of calculation and by this feature it scores over conventional arithmetic.

In ancient India conventional mathematics termed Ganitam was known before the development of algebra. This is borne out by the name - Bijaganitam, which was given to the algebraic form of computation. Bijaganitam means 'the other mathematics' (Bija means 'another' or 'second' and Ganitam means mathematics). The fact that this name was chosen for this system of computation implies that it was recognised as a parallel system of computation, different from the conventional one which was used since the past and was till then the only one. Some have interpreted the term Bija to mean seed, symbolizing origin or beginning. And the inference that Bijaganitam was the original form of computation is derived. Credence is lent to this view by the existence of mathematics in the Vedic literature which was also shorthand method of computation. But whatever the origin of algebra, it is certain that this technique of computation Originated in India and was current around 1500 years back. Aryabhatta an Indian mathematican who lived in the 5th century A.D. has referred to Bijaganitam in his treatise on Mathematics, Aryabhattiya. An Indian mathematician - astronomer, Bhaskaracharya has also authored a treatise on this subject. the treatise which is dated around the 12th century A.D. is entitled 'Siddhanta-Shiromani' of which one section is entitled Bijaganitam.

Thus the technique of algebraic computation was known and was developed in India in earlier times. From the 13th century onwards, India was subject to invasions from the Arabs and other Islamised communities like the Turks and Afghans. Alongwith these invader: came chroniclers and critics like Al-beruni who studied Indian society and polity. The Indian system of mathematics could no have escaped their attention. It was also the age of the Islamic Renaissance and the Arabs generally improved upon the arts and sciences that they imbibed from the land they overran during their great Jehad.

In the words of the Australian Indologist A.L. Basham (A.L. Basham; The Wonder That was India.) "... the world owes most to India in the realm of mathematics, which was developed in the Gupta period to a stage more advanced than that reached by any other nation of antiquity. The success of Indian mathematics was mainly due to the fact that Indians had a clear conception of the abstract number as distinct from the numerical quantity of objects or spatial extension."

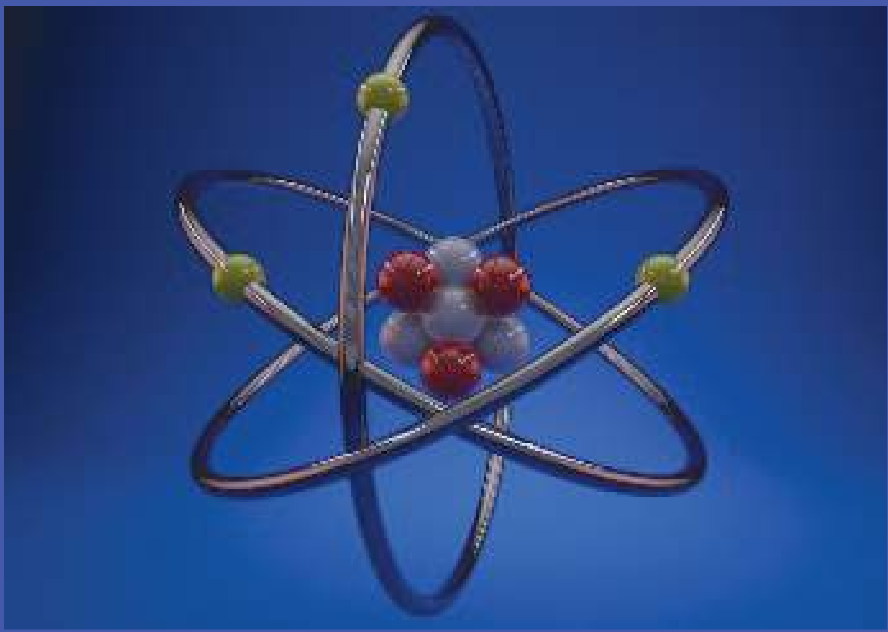
Thus Indians could take their mathematical concepts to an abstract plane and with the aid of a simple numerical notation devise a rudimentary algebra as against the Greeks or the ancient Egyptians who due to their concern with the immediate measurement of physical objects remained confined to Mensuration and Geometry.

A portion of a dedication tablet in a rock-cut Vishnu temple in Gwalior built in 876 AD. The number 270 seen in the inscription features the oldest extant zero in India.

The system of mathematics the Arabs observed in India was adapted by them and given the name 'Al-Jabr' meaning 'the reunion of broken parts'. 'Al' means 'The' & 'Jabr' mean 'reunion'. This name given by the Arabs indicates that they took it from an external source and amalgamated it with their concepts about mathematics.

In the year 1816, an Englishman by the name James Taylor translated Bhaskara's Leelavati into English. A second English translation appeared in the following year (1817) by the English astronomer Henry Thomas Colebruke. Thus the works of this Indian mathematician astronomer were made known to the western world nearly 700 years after he had penned them, although his ideas had already reached the west through the Arabs many centuries earlier.

ATOMIC THEORY



John Dalton (1766 – 1844), an English chemist and physicist, is the man credited today with the development of atomic theory. However, a theory of atoms was actually formulated2,500 years before Dalton by an Indian sage and philosopher, known as Acharya Kanad.
Acharya Kanad was born in 600 BC in Prabhas Kshetra (near Dwaraka) in Gujarat, India. His real name was Kashyap.
Kanad pursued his fascination with the unseen world and with conceptualising the idea of the smallest particle. He began writing down his ideas and teaching them to others. Thus, people began calling him 'Acharya' ('the teacher'), hence the name Acharya Kanad ('the teacher of small particles')

Kanad's conception of Anu (the atom)

Kanad was walking with food in his hand, breaking it into small pieces when he realised that he was unable to divide the food into any further parts, it was too small. From this moment, Kanad conceptualised the idea of a particle that could not be divided any further. He called that indivisible matter Parmanu, or anu (atom).
Acharya Kanad proposed that this indivisible matter could not be sensed through any human organ or seen by the naked eye, and that an inherent urge made one Parmanu combine with another. When two Parmanu belonging to one class of substance combined, a dwinuka (binary molecule) was the result. This dwinuka had properties similar to the two parent Parmanu.
Kanad suggested that it was the different combinations of Parmanu which produced different types of substances. He also put forward the idea that atoms could be combined in various ways to produce chemical changes in presence of other factors such as heat. He gave blackening of earthen pot and ripening of fruit as examples of this phenomenon.
Acharya Kanad founded the Vaisheshika school of philosophy where he taught his ideas about the atom and the nature of the universe. He wrote a book on his research "Vaisheshik Darshan" and became known as "The Father of Atomic theory." In the West, atomism emerged in the 5th century BC with the ancient Greeks Leucippus and Democritus. Whether Indian culture influenced Greek or vice versa or whether both evolved independently is a matter of dispute. Kanad is reporting to have said: "Every object of creation is made of atoms which in turn connect with each other to form molecules." His theory of the atom was abstract and enmeshed in philosophy as they were based on logic and not on personal experience or experimentation.

Computational Language

Pāṇini's fourth century BCE Sanskrit grammar uses rewrite rules guided by an explicit and formal metalanguage. The metalanguage makes extensive use of auxiliary markers, in the form of Sanskrit phonemes, to control grammatical derivations. The method of auxiliary markers was rediscovered by Emil Post in the 1920s and shown capable of representing universal computation. The same potential computational strength of Pāṇini's metalanguage follows as a consequence. Pāṇini's formal achievement is philosophically distinctive as his grammar is constructed as an extension of spoken Sanskrit, in contrast to the implicit inscription of contemporary formalisms. Pāṇini's example shows that the differences between natural and artificial computing languages are much smaller than often thought. Not because natural languages are, or are close to

being, computing languages, but because the construction of computing languages is apparently just a continuation of natural language constructions by their own means.

Economic Theory

The known Economic sciences of India begins with the Indus Valley civilization. The Indus civilization's economy appears to have depended significantly on trade, which was facilitated by advances in transport. Around 600 BC, the Mahajanapadas minted punch-marked silver coins. The period was marked by intensive trade activity and urban development. By 300 B.C., the Maurya Empire united most of the Indian subcontinent. The political unity and military security allowed for a common economic system and enhanced trade and commerce, with increased agricultural productivity. For the next 1500 years, India produced its classical civilizations such as the Rashtrakutas, Hoysalas and Western Gangas. During this period India is estimated to have had the largest economy of the ancient and medieval world between until 17th century AD, controlling between one third and one fourth of the world's wealth up to the time of Maratha Empire, from whence it rapidly declined during European colonization.

According to economic historian Angus Maddison in his book The World Economy: A Millennial Perspective, India was the richest country in the world and had the world's largest economy until the 17th century AD.

While India's many kingdoms and rulers issued coins, barter was still widely prevalent. Villages paid a portion of their agricultural produce as revenue while its craftsmen received a stipend out of the crops at harvest time for their services. Each village, as an economic unit, was mostly self-sufficient.

According to economic historian Angus Maddison in his book Contours of the world economy, 1–2030 AD: essays in macro-economic history, India had the world's largest economy during the years 1 AD and 1000 AD.

During the Maurya Empire (c. 321–185 BC), there were a number of important changes and developments to the Indian economy. The empire spent considerable resources building roads and maintaining them throughout India.

Engineering

Engineering

India's urban civilization is traceable to Mohenjodaro and Harappa, now in Pakistan, where planned urban townships existed 5000 years before. From then onwards, the ancient Indian architecture and civil engineering continued to develop and grow. It found manifestation in construction of temples, palaces and forts across the Indian peninsula and the neighbouring regions.

During the periods of Kushan Empire and Maurya empires, the Indian architecture and civil engineering reached to regions like Baluchistan and Afghanistan. Statues of Buddha were cut out, covering entire mountain faces and cliffs, like Buddhas of Bamiyan, Afghanistan. Angkor Wat is a living testimony to the contribution of Indian civil engineering and architecture to the Cambodian Khmer heritage in the field of architecture and civil engineering.

In mainland India of today, there are several marvels of ancient India's architectural heritage, including World heritage sites like Ajanta, Ellora, Khajuraho, Mahabodhi Temple, Sanchi, Brihadisvara Temple and Mahabalipuram.

Standardization

Standard weights and measures have existed in the Indus Valley Civilization since the 5th millennium BCE. The centralized weight and measure system served the commercial interest of Indus merchants as smaller weight measures were used to measure luxury goods while larger weights were employed for buying bulkier items, such as food grains etc. Weights existed in multiples of a standard weight and in categories. Technical standardization enabled gauging devices to be effectively used in angular measurement and measurement for construction. Uniform units of length were used in the planning of towns such as Lothal, Surkotada, Kalibangan, Dolavira, Harappa, and Mohenjo-daro. The weights and measures of the Indus civilization also reached Persia and Central Asia, where they were further modified. Shigeo Iwata describes the excavated weights unearthed from the Indus civilization: A total of 558 weights were excavated from Mohenjodaro, Harappa, and Chanhu-daro, not including defective weights. They did not find statistically significant differences between weights that were excavated from five different layers, each measuring about 1.5 m in depth. This was evidence that strong control existed for at least a 500-year period. The 13.7-g weight seems to be one of the units used in the Indus valley. The notation was based on the binary anddecimal systems. Eighty-three percent of the weights which were excavated from the above three cities were cubic, and 68% were made of chert.

Rulers made from Ivory were in use by the Indus Valley Civilization prior to 1500 BCE.Excavations at Lothal (2400 BCE) have yielded one such ruler calibrated to about 1⁄16 inch (1.6 mm). Ian Whitelaw (2007)—on the subject of a ruler excavated from the Mohenjo-daro site—writes that: 'the Mohenjo-Daro ruler is divided into units corresponding to 1.32 inches (33.5 mm) and these are marked out in decimal subdivisions with amazing accuracy—to within 0.005 of an inch. Ancient bricks found throughout the region have dimensions that correspond to these units. The Indus civilization constructed pan balances made of copper, bronze, and ceramics.

INTERNET OF THINGS

EXPLOSION OF POSSIBILITIES

The Internet of Things (IoT) refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines and other physical objects. IoT is expected to spread rapidly over the coming years and this convergence will unleash a new dimension of services that improve the quality of life of consumers and productivity of enterprises, unlocking an opportunity that the GSMA refers to as the 'Connected Life'.

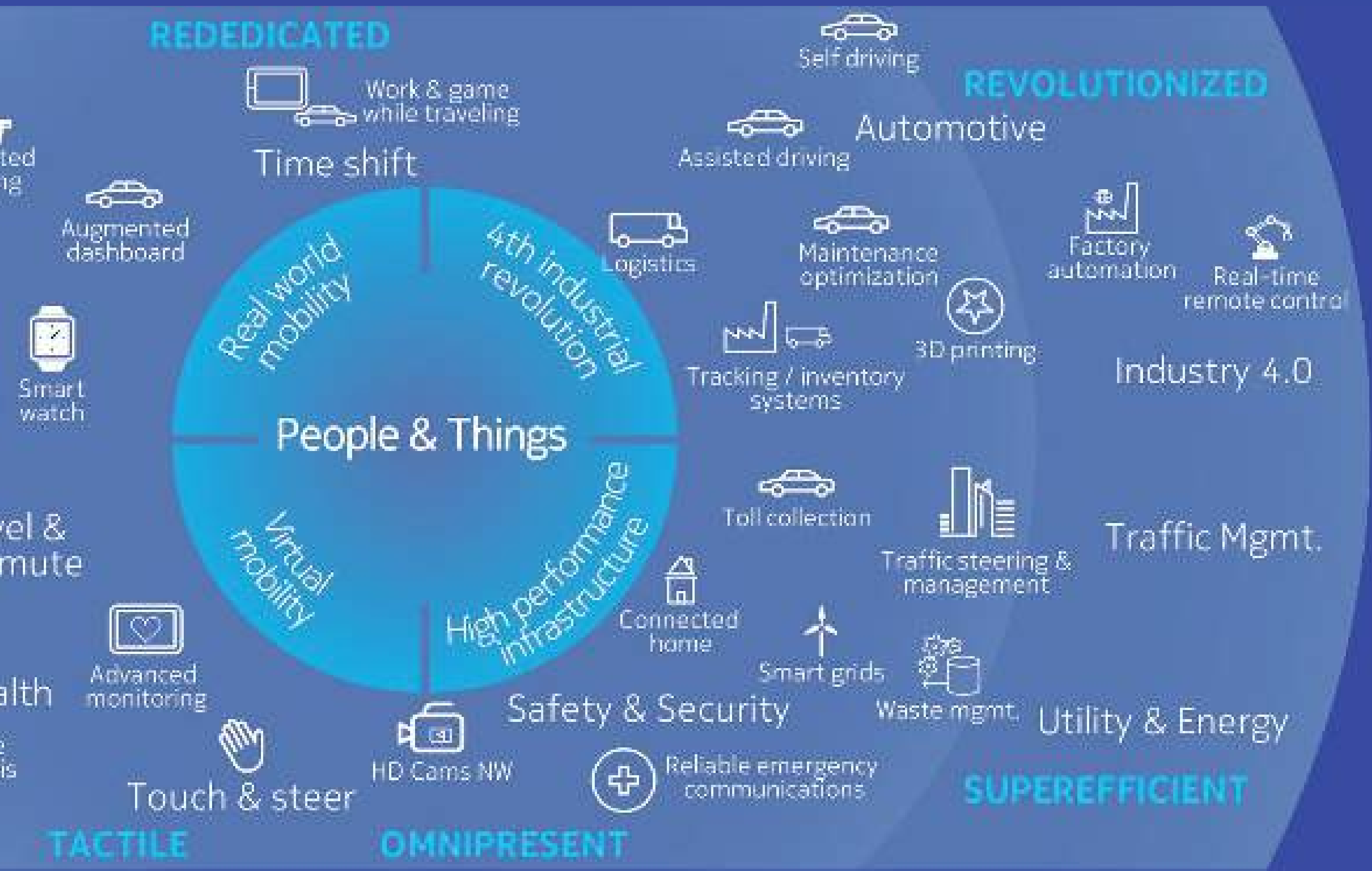
For consumers, the IoT has the potential to deliver solutions that dramatically improve energy efficiency, security, health, education and many other aspects of daily life. For enterprises, IoT can underpin solutions that improve decision-making and productivity in manufacturing, retail, agriculture and other sectors.

The Internet of Things is an emerging topic of technical, social, and economic significance.

Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025.

Key concepts that serve as a foundation for exploring the opportunities and challenges of IoT include:

· IoT Definitions: The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human



intervention. There is, however, no single, universal definition.

· Enabling Technologies: The concept of combining computers, sensors, and networks to monitor and control devices has existed for decades. The recent confluence of several technology market trends, however, is bringing the Internet of Things closer to widespread reality. These include Ubiquitous Connectivity, Widespread Adoption of IP-based Networking, Computing Economics, Miniaturization, Advances in Data Analytics, and the Rise of Cloud Computing.

· Connectivity Models: IoT implementations use different technical communications models, each with its own characteristics. Four common communications models described by the Internet Architecture Board include: Device-to-Device, Device-to-Cloud, Device-to-Gateway, and Back-End Data-Sharing. These models highlight the flexibility in the ways that IoT devices can connect and provide value to the user.

· Transformational Potential: If the projections and trends towards IoT become reality, it may force a shift in thinking about the implications and issues in a world where the most common interaction with the Internet comes from passive engagement with connected objects rather than active engagement with content. The potential realization of this outcome – a "hyperconnected world" -- is testament to the general-purpose nature of the Internet architecture itself, which does not place inherent limitations on the applications or services that can make use of the technology. Five key IoT issue areas are examined to explore some of the most pressing challenges and questions related to the technology. These include security; privacy; interoperability and standards; legal, regulatory, and rights; and emerging economies and development.

As with many new concepts, IoT's roots can be traced back to the Massachusetts Institute of Technology (MIT), from work at the Auto-ID Center. Founded in 1999, this group was working in the field of networked radio frequency identification (RFID) and emerging sensing technologies. The labs consisted of seven research universities located across four continents.

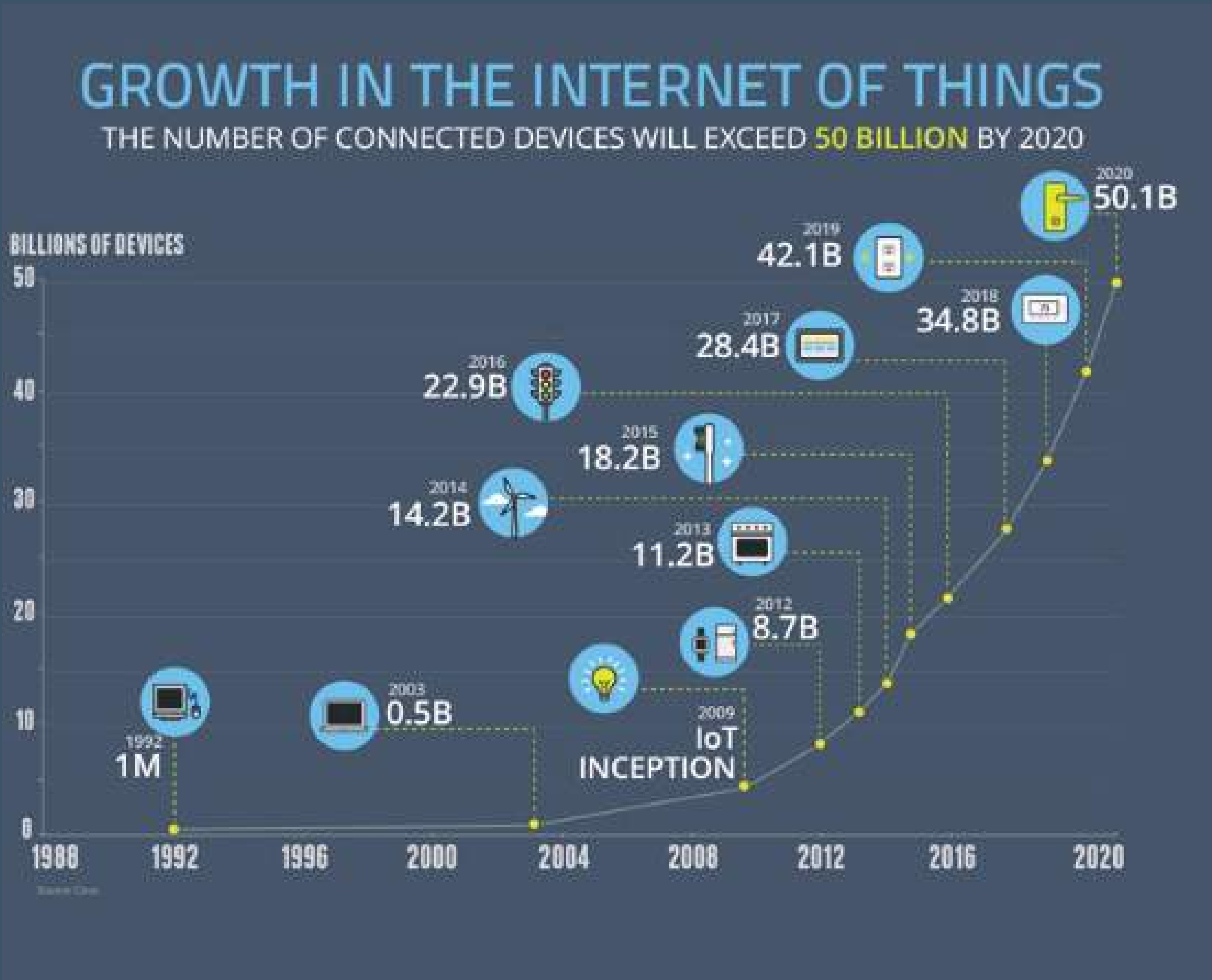
1, Before we talk about the current state of IoT, it is important to agree on a definition. According to the Cisco Internet Business Solutions Group (IBSG), IoT is simply the point in time when more "things or objects" were connected to the Internet than people.
2 , In 2003, there were approximately 6.3 billion people living on the planet and 500 million devices connected to the Internet.3 By dividing the number of connected devices by the world population, we find that there was less than one (0.08) device for every person.

Current Context

As the planet's population continues to increase, it becomes even more important for people to become stewards of the earth and its resources. In addition, people desire to live healthy, fulfilling, and comfortable lives for themselves, their families, and those they care about. By combining the ability of the next evolution of the Internet (IoT) to sense, collect, transmit, analyze, and distribute data on a massive scale with the way people process information, humanity will have the knowledge and wisdom it needs not only to survive, but to thrive in the coming months, years, decades, and centuries.

We Evolve Because We Communicate

Humans evolve because they communicate. Once fire was discovered and shared, for example, it didn't need to be rediscovered, only communicated. A more modern-day example is the discovery of the helix structure of DNA, molecules that carry genetic information from one generation to another. After the article was published in a scientific paper by James
Watson and Francis Crick in April 1953, the disciplines of medicine and genetics were able to build on this information to take giant leaps forward. This principle of sharing information and building on discoveries can best be understood by examining how humans process data . From bottom to top, the pyramid layers include data, information, knowledge, and wisdom. Data is the raw material that is processed into information. Individual data by itself is not very useful, but volumes of it can identify trends and patterns. This and other sources of information come together to form knowledge. In the simplest sense, knowledge is information of which someone is aware. Wisdom is then born



from knowledge plus experience. While knowledge changes over time, wisdom is timeless, and it all begins with the acquisition of data.

Humans Turn Data into Wisdom

It is also important to note there is a direct correlation between the input (data) and output (wisdom). The more data that is created, the more knowledge and wisdom people can obtain.

IoT dramatically increases the amount of data available for us to process. This, coupled with
the Internet's ability to communicate this data, will enable people to advance even further.

IoT in 2017

IoT Applications

When we crossed the threshold of connecting more objects than people to the Internet, a huge window of opportunity opened for the creation of applications in the areas of automation, sensing, and machine-to-machine communication. In fact, the possibilities are almost endless. The following examples highlight some of the ways IoT is changing people's lives for the better.

The Cow.

In the world of IoT, even cows will be connected. A special report in *The Economist* titled "Augmented Business" described how cows will be monitored. Sparked, a Dutch start-up company, implants sensors in the ears of cattle. This allows farmers to monitor

cows' health and track their movements, ensuring a healthier, more plentiful supply of milk for people to consume. On average, each cow generates about 200 megabytes of information a year.

As the Internet of Things evolves, the proliferation of smart connected devices supported by mobile networks, providing pervasive and seamless connectivity, will unlock opportunities to provide life-enhancing services for consumers while boosting productivity for enterprises.

For consumers, connectivity provided by the IoT could enhance their quality of life in multiple ways, such as, but not limited to, energy efficiency and security at home and in the city.

In the home, the integration of connected smart devices and cloud-based services will help address the pressing issue of energy efficiency and security. Connected smart devices will enable a reduction in utility bills and outages, while also improving home security via remote monitoring.

In cities, the development of smart grids, data analytics and autonomous vehicles will provide an intelligent platform to deliver innovations in energy management, traffic management and security, sharing the benefits of this technology throughout society.

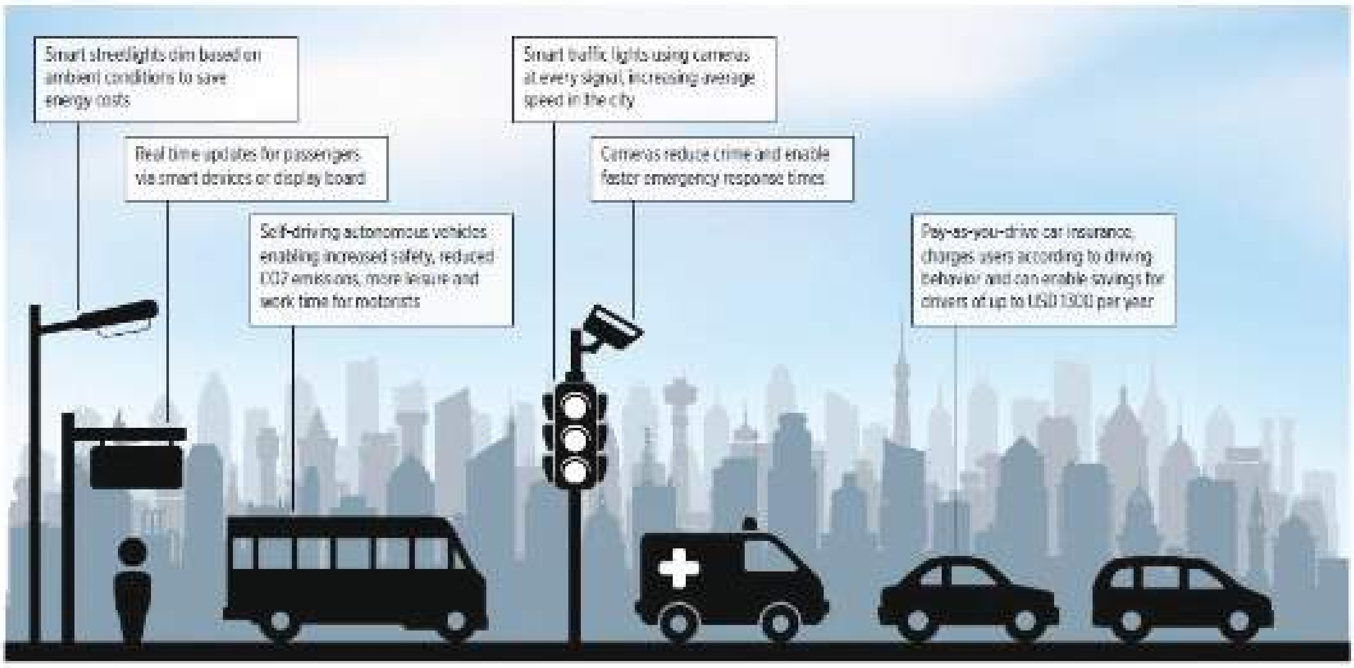
The IoT will also help widen access and improve quality of education and health. As demand for healthcare doubles8, connected smart devices will help address this challenge by supporting a range of e-health services that improve access and enable monitoring of chronic diseases and age-related conditions in the home. In doing so, they will improve the quality of care and qualityof life for patients, while reducing the strain on the wider healthcare system.

In education, mobile-enabled solutions will tailor the learning process to each student's needs, improving overall proficiency levels, while linking virtual and physical classrooms to make learning more convenient and accessible.

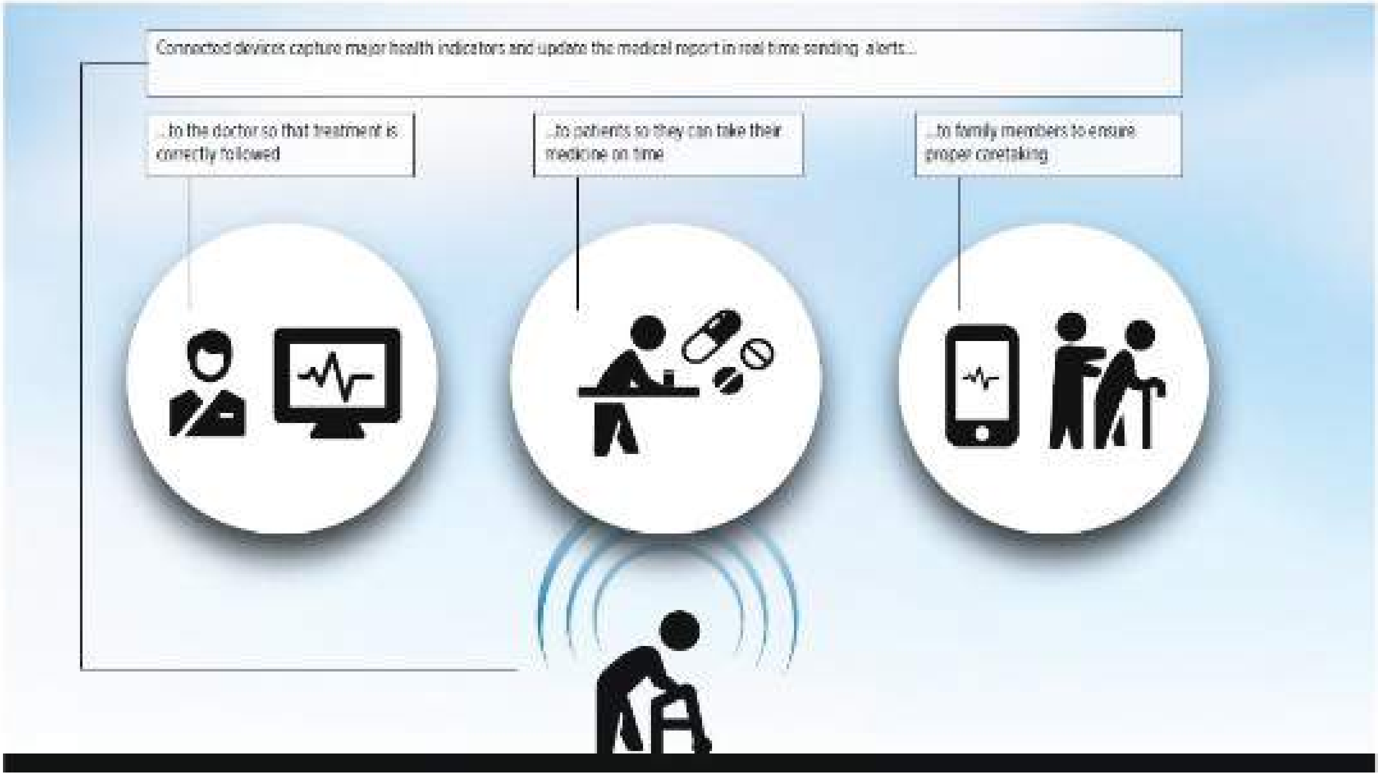
Mobile education solutions have already been shown to improve learners' proficiency rates and reduce dropout rates, and have the potential to enable, by 2017, the education of up to 180 million additional students in developing countries who will be able to stay in school due to mEducation

For enterprises, the ability of IoT to combine innovations in data analytics, 3D printing and sensors, will improve productivity by enabling a step change in the quality of decision making, efficiency of production, personalisation of

IOT SMART CITIES APPLICATIONS



IOT HEALTH APPLICATIONS



retail and productivity of food production.

The modern age of business and consumerism is increasingly driven in a global fashion with international brands in many vertical industries. In order to support the development of a viable service ecosystem, i.e. one that meets customer expectations in an economical manner, globally consistent service enablers will be a key requirement.

For companies in vertical industries, the ability to deploy their services across several countries by partnering with a single mobile operator, or an operator partnership or alliance, not only helps guarantee a consistent end customer experience but also allows for the centralisation of manufacturing and planning processes while also leveraging common management systems for consistent policy controls (e.g. for provisioning, customer care, security, data protection, privacy, billing and reporting). This in turn allows the service partners to benefit from economies of scale for service delivery that helps accelerate speed and quality of deployment for the market as a whole. Furthermore, the resulting economies of scale also enable service delivery in markets where the cost of creating a bespoke local service would make serving the market economically unviable.

Operators are already taking the lead in supporting such global service launches in early market categories such as automotive, health and consumer electronics. With the emergence of new products in adjacent categories such as healthcare, wearables and consumer electronics the importance of the ability to support large-scale global deployments is likely to accelerate. The template for an M2M roaming annex to existing roaming agreements, developed by the GSMA in 2012, is already being utilised by operators and serves as a prime example of an approach that affords the opportunity to reduce fragmentation while allowing the identification and differentiation of connected IoT devices.

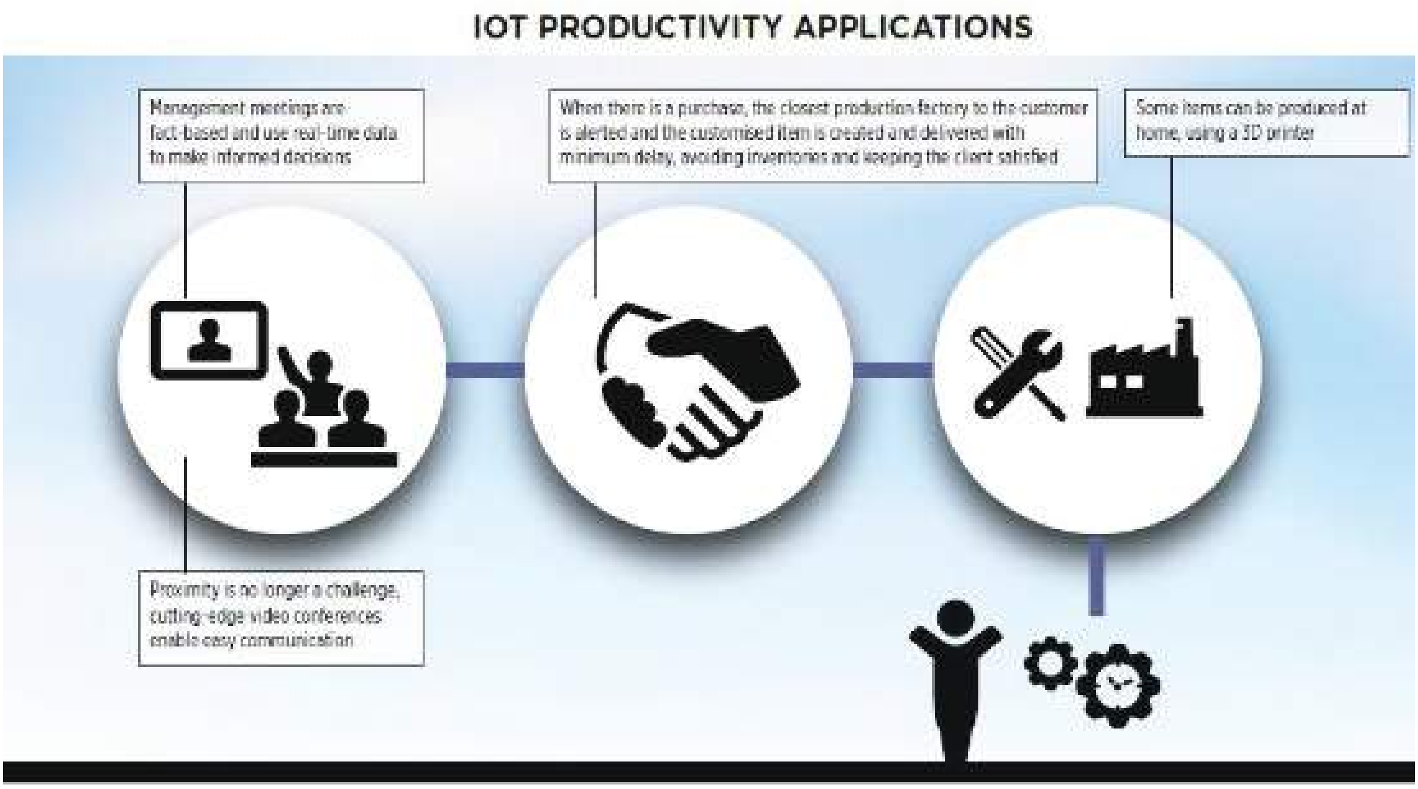
horizontal capabilities such as remote provisioning of IoT devices, building platforms that allow for management of business rules, reporting, support for Application Programming Interfaces (APIs) and the management

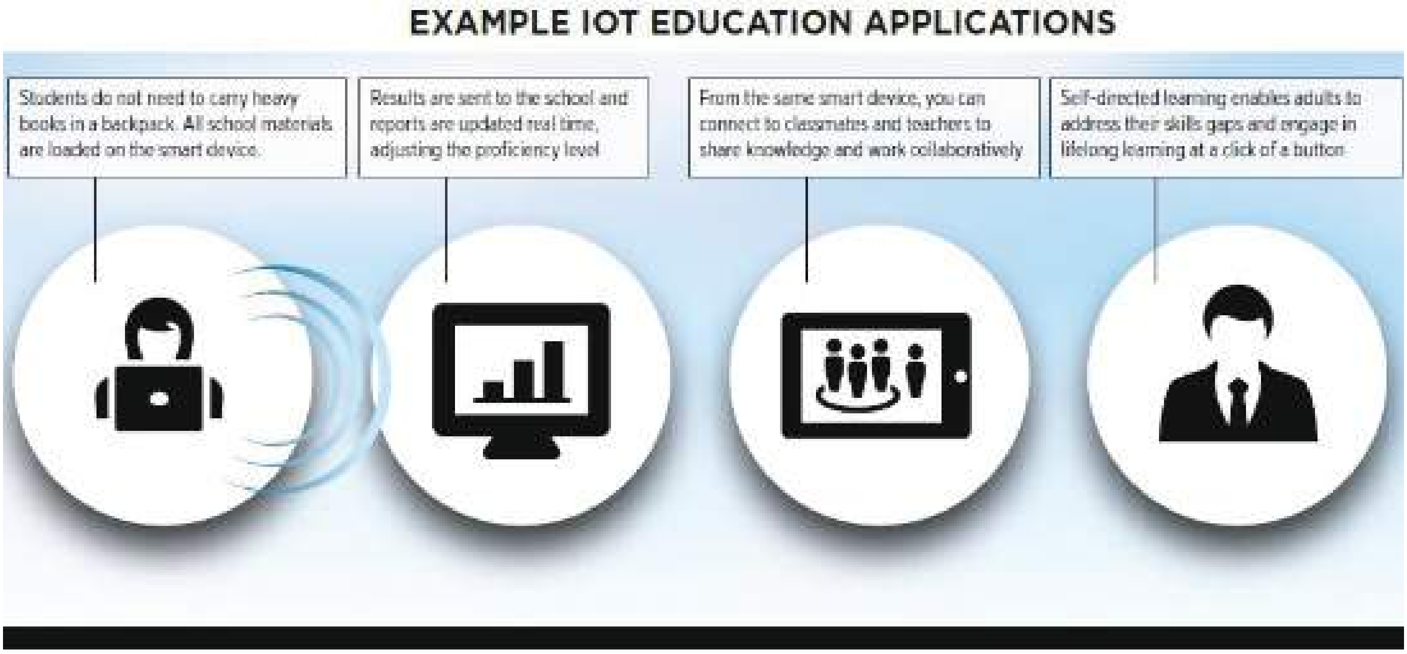
and presentation of data. Moreover, 'Big Data' analytics is set to become a key part of IoT services in the future, with operators increasingly looking at ways to analyse data from various sources and create new service lines.

An area in which there has been recent innovation is the capability for the remote provisioning of IoT devices. In some connected devices or equipment, the module with the SIM card needs to be inserted in the machine and hermetically sealed during the production process. Examples include tamper-proof security or alarm systems. Other pieces of connected equipment are located in remote or hazardous locations, such as weather, pipeline or geology sensors, or equipment in chemical plants, meaning it is difficult or impossible to access the module after deployment.

The IoT will increase the range of services, each requiring varying levels of bandwidth, mobility and latency. For example, services that are related to public safety or personal safety will generally, require low latency, but not high bandwidth per se. alternatively, services that provide surveillance might also require high bandwidth. Due to the differing level of service demand, mobile networks may need the ability to identify the service which is generating traffic and meet its specific needs. For example, alert services related to public safety or personal health would require a higher priority compared to metering information, which is a normal monitoring activity.

Varying levels of mobility (the degree to which devices and applications need to be nomadic) is another important characteristic of IoT service demand. For nomadic services, location information and geo-fencing becomes a crucial enabler. Proximity services in general will play an important role in the IoT ecosystem. In this context, the mobile network faces the challenge of being able to recognise different type of devices. For example, in the automotive sector, only cars in the





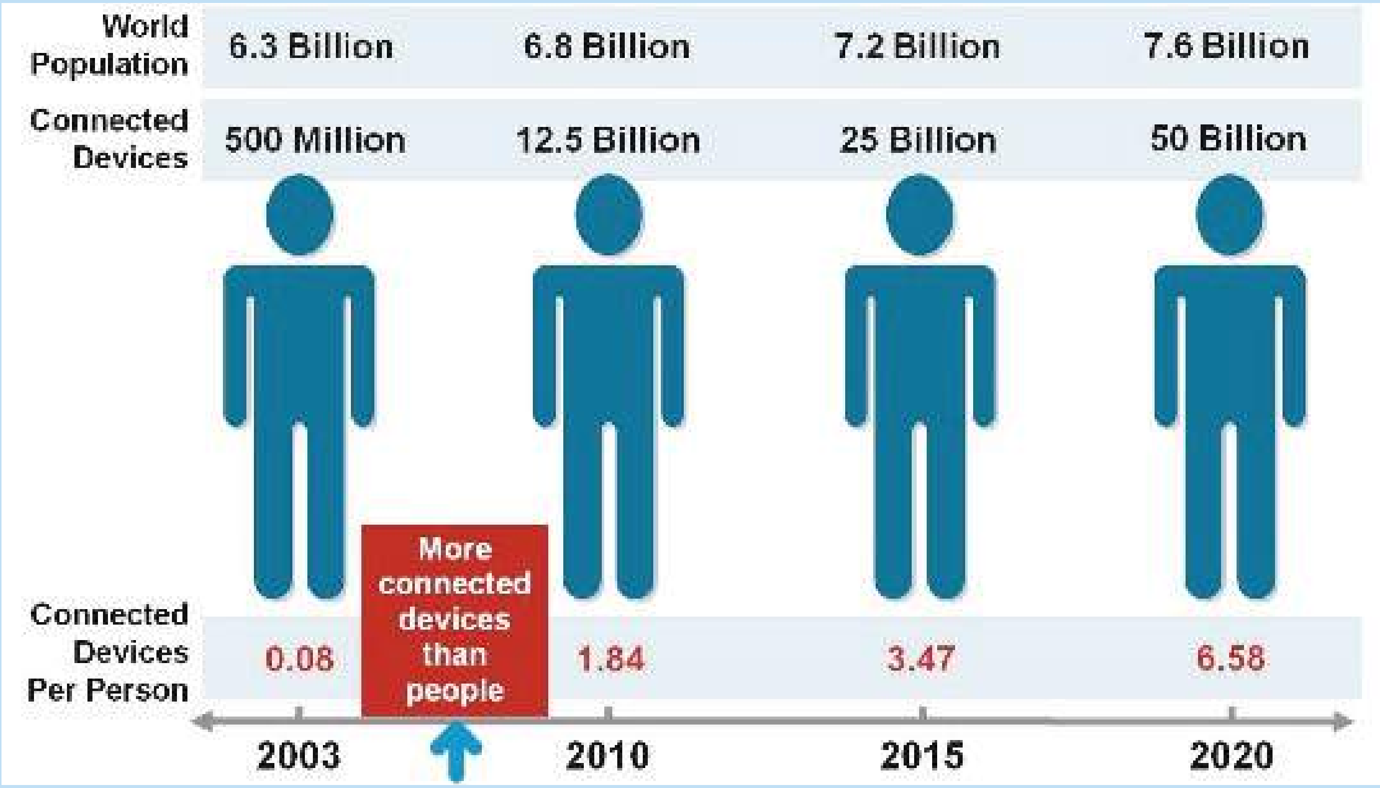
proximity of an accident need to be notified, rather than every vehicle. Conversely, there are devices and applications that are not mobile by nature, such as a smart meter or a street lamp. Any movement of such devices/ applications might indicate an anomaly in the service.

Another important characteristic of IoT services can be the deployment of a large number of the same type of devices and applications. Each device and application performs the same activity and transports information to a service centre at the same time. Regardless of the amount of data transmitted by each device, this simple operation could cause network congestion. Mobile networks need to provide several mechanisms to protect and better utilise their capabilities for delivering such M2M/IoT services. Mechanisms for remotely managing such devices and applications could allow intelligent scheduling, which would facilitate an appropriate application development and reduce the vulnerability of the network to application misbehaviour.

An additional feature of the IoT market is, that in some scenarios, devices and applications may be deployed and actively work for a large number of years, operating on batteries or using limited power. In this case, the communication module needs to consume very little energy to guarantee a longer device lifetime.

In summary, the IoT will require mobile networks to offer a much more diversified set of capabilities, while providing protection mechanisms for identifying and blocking any application misbehaviour and guaranteeing all other services. Mobile operators are working to identify these requirements and develop appropriate capabilities in order to support the vast range of IoT applications.

IOT Penetration Estimate



"

have courage , to think differently,
to invent,
to travel the unexplored path,
to discover the impossible
&
to conquer the problems and succeed... "

Kalam.

KALAM.

Avul Pakir Jainulabdeen Abdul Kalam was a President like no other. The floppy silvery mop curling on his forehead, the twinkling eyes and the ever smiling visage seemed to radiate boundless radiant energy and positivity. Kalam embodied the new India story, born into a poor Muslim family in Tamil Nadu, he rose by sheer force of education to become a missile scientist, the "missile man of India" becoming chief scientific adviser to the Prime Minister, then secretary of the DRDO, and then President of India.

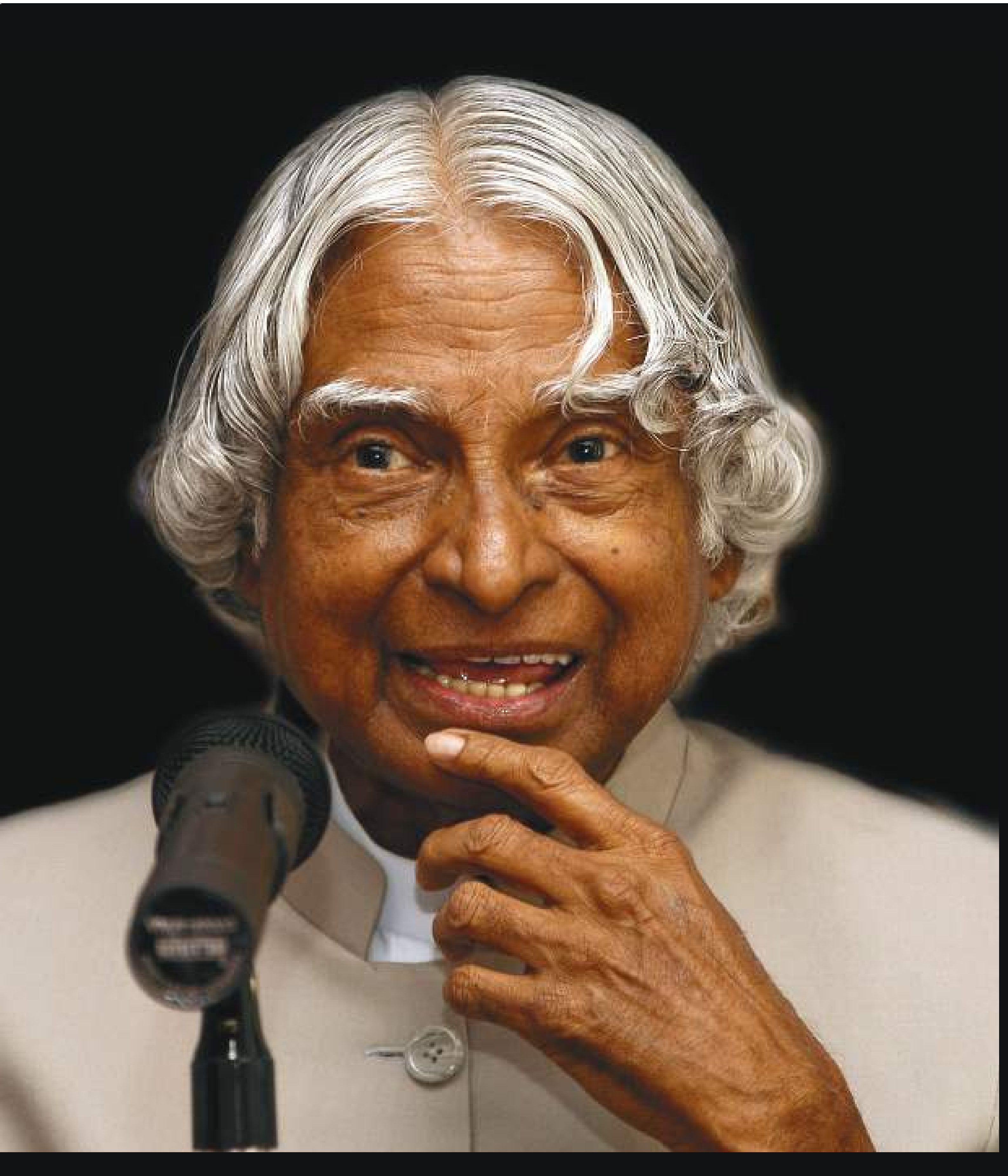
To a new aspirational India he was a President refreshingly free of political affiliation, a genial figure who embodied the joy and adventure of science, whose messages were so attractive to the young precisely because they were so simple and straightforward.

Kalam's weak moment may have been when he was forced to sign the controversial dissolution of the Bihar assembly in the infamous order at midnight in Moscow, but then he also showed he was no one's man when he sent back a number of NDA proposals for reconsideration, just as he later sent back twice the file on Sonia Gandhi's office of profit issue.

He also redefined the presidency in unique ways. His herbal garden at Rashtrapati Bhavan, the instant connect with kids, his own unquestioned integrity, even the fact that he was a lifelong bachelor, made him somewhat of an urban legend for a generation looking for homegrown heroes. As the Missile man of India -- the fact that he was responsible for the development of the five missiles, Prithvi, Trishul, Akash, Nag and Agni -- added to his charm for the young.

Kalam's biggest asset for a changing India was that he was resolutely non-political, an outsider in politics, someone who instead of preserving Rashtrapati Bhavan only for high official ceremonies, opened it up for the public. In fact, he did to the Indian presidency what princess Diana to some extent did to the British monarchy, he demystified it, while making himself a feel good first citizen, as if his moral purpose lay not in ceremonial matters of state but among school and college students.

He himself seemed to prefer non politicians as president. Indians relied on Kalam to do the right thing. When the prospect of being drawn into a contest against Pranab Mukherjee arose, Kalam said, "My conscience is not permitting me to contest." After he



ceased being president, travellers were often pleasantly surprised to see Kalam standing in queue at security check at airports, accepting no special VIP privileges.

His messages were always simple. His books contained simple inspiring messages and became best sellers. His mantra was in no-nonsense prescriptions on the way forward. In India 2020 he wrote, "I have identified five areas where India has a core competence for integrated action: (1) agriculture and food processing; (2) education and healthcare; (3) information and communication technology; (4) infrastructure, reliable and quality electric power, surface transport and infrastructure for all parts of the country; and (5) self-reliance in critical technologies."

His best-selling autobiography Wings of Fire was written in a beguilingly simple style and told a story of journey from hardship to professional success in a way that mirrored the aspirations of India in the 21st century.

Even when he was no longer president, Kalam tended to top popularity charts. Perhaps that's because he constantly came across as someone bursting with new ideas, ever enthusiastic, someone who after piloting a Sukhoi at the age of 74, exulted that his childhood dream had been fulfilled.

Kalam was the president that 21st century India warmed to, an India that was trying to wrench itself free of the clutches of caste religion and family. He was the president who embodied high science as well as one who knew about the life of third class train travel and long queues for water. He was the president who designed missile programmes and flew Sukhois but one whose message was primarily for kids and not for ceremonial high grandees. His magnificent eccentricites made him lovable, his life was a mirror of an aspirational India seeking a new narrative.

Early Life

Dr Kalam's Home in Rameshwaram

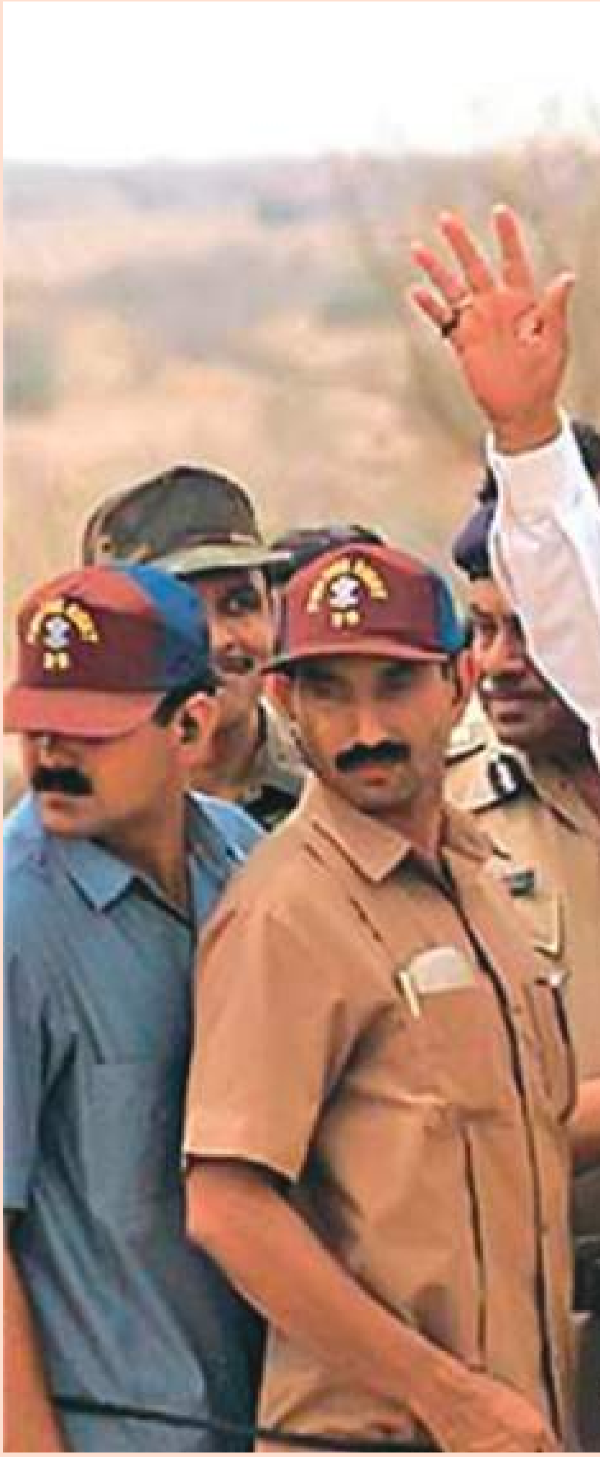
Kalam with his friends.

Dr Sarabhai And Dr Kalam at Thumba

Avul Pakir Jainulabdeen Abdul Kalam was born into a Muslim family on October 15, 1931, on the island of Dhanushkodi off the southeastern coast of India. He developed an early fascination with flight by watching birds, which developed into an interest in aeronautics after he saw a newspaper article about a British fighter plane.

Despite his modest beginnings – his dad built and rented boats – Kalam was a bright student who showed promise in science and mathematics. He attended St. Joseph's College, and went on to earn a degree in aeronautical engineering from the Madras Institute of Technology.

Life, the Kalam way,



· After graduating from MIT, Kalam took up the position of chief scientist at the Aeronautical Development Establishment of Defense Research and Development Organization (DRDO). However, the profile didn't appeal Kalam much who shifted to the Indian Space Research Organization (ISRO) where he was the project director of India's first indigenous Satellite Launch Vehicle.

· His years at the ISRO were the most crucial ones, as they left a lasting impact on him. Kalam lead many projects and turned out to be successful each time.

· In the 1970s, Kalam directed two projects, namely, Project Devil and Project Valiant, which sought to develop ballistic missiles from the technology of the successful SLV programme.

· A milestone was achieved when locally built Rohini-1 was launched into space, using the SLV rocket. Upon watching the raving success of Kalam, the government agreed for initiation of an advanced missile program under his directorship. He played a pivotal role in developing missiles under the missions Agni and Prithvi.

· Kalam was the Chief Executive of the Integrated Guided Missile Development Program (I.G.M.D.P) which researched in simultaneous development of a quiver of missiles instead of taking planned missiles one by one.

· From 1992 until 1999, Kalam was appointed as the Chief Scientific Adviser to the Prime Minister and the Secretary of Defence Research and Development Organisation. It was during this time that Kalam served as the Chief Project Coordinator for Pokhran II nuclear tests, after which he was fondly called the "Missile Man of India".

· Kalam succeeded K. R. Narayan to serve as the 11th President of India from 2002 until 2007. It was a highly one-sided contest. With his appointment, Kalam became the first scientist and first ever bachelor to occupy the Rastrapati Bhawan.

· During his tenure as a President, Kalam was both appreciated and criticised. The latter was mostly due to his inaction in deciding the fate of 20 mercy petitioners.

· In addition to all the profiles that Dr Kalam held, he authored numerous influential and inspirational books. Amongst all his books, "India 2020" was the widely read and appreciated one. It forecast an action plan which advocated India turning into a knowledge superpower and as one of the developed nations of the world by the year 2020. His other books include, "Ignited Minds", "Mission India", "Inspiring Thoughts" and "The Luminous Sparks".

Dr APJ Abdul Kalam with former Prime Minister Shri AB Vajpayee at Pokhran nuclear test site.

· In 2011, he launched his mission for the youth of the nation called the “What Can I Give Movement” with the main aim to defeat corruption in India.
· After completing his term as President, Dr Kalam served as visiting professor in various esteemed institutes and universities of India, such as Indian Institute of Management Ahmedabad and Indore. He also served as Chancellor of Indian Institute of Space Science and Technology Thiruvananthapuram, Aerospace Engineering at Anna University (Chennai), JSS University (Mysore).

The breakthrough

The breakthrough in his illustrious career came when he was welcomed at ISRO (Indian Space Research Organization) and appointed the project director of the SLV-III mission – India's first satellite launch programme! And thus, he became the Missile Man of the country.

In the 1980s he led India's missile programme. Under his leadership, India became a major military power after the successes of Agni and Prithvi

Dr Kalam not only successfully launched the satellite Rohini in 1980, but also expanded India's space programme to bring it at par with the powers that be of the world. This man was responsible for empowering India on the basis of its military strength after he took the reins of the country's missile programme in his hands.

Brilliance never goes unnoticed, and in 1992, Dr Kalam was appointed chief scientific advisor to the prime minister. He was spearheading India's missile strategy and power at a time when the country was struggling with maintaining friendly ties with its neighbor Pakistan as well as establishing a stronghold in international corridors.

He gave away all his wealth and savings to a trust called PURA (Providing Urban Amenities to Rural Areas) that he founded. A rocket scientist and president of a nation with no bank balance – could there be a better example of a greater man?

In 1998, the Pokhran-II tests cemented India's nuclear prowess. Mr Kalam played the pivotal role in the project. He firmly told the international community that such arms were only to deter other nations from trying to subjugate India, and were only to be used as "weapons of peace".

In 1998, along with cardiologist Dr.Soma Raju, Kalam developed a low cost Coronary stent. It was named as "Kalam-Raju Stent" honouring them. In 2012, the duo designed a rugged tablet PC for health care in rural areas, which was named as "Kalam-Raju Tablet".

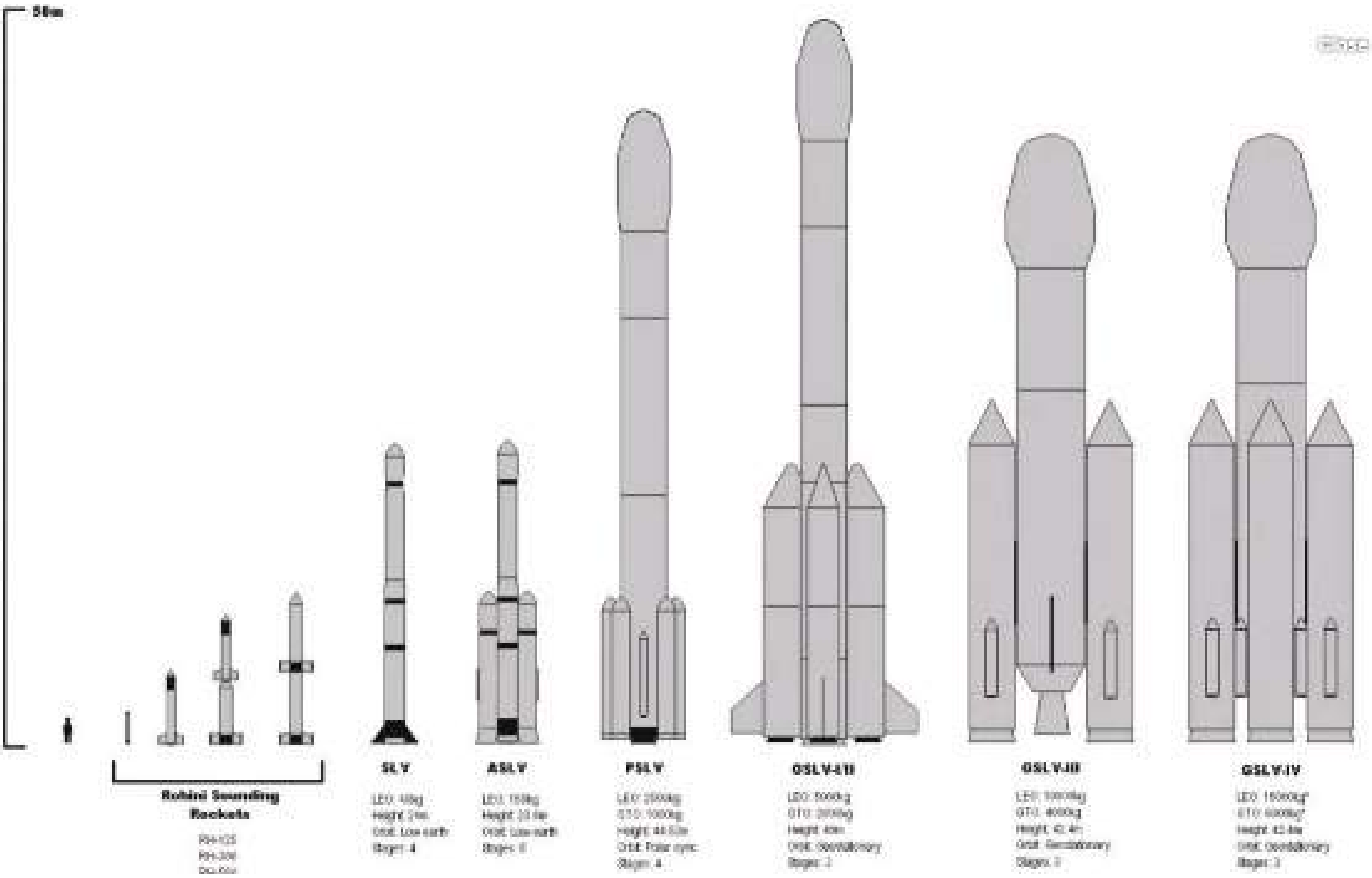
Dr. Kalam with Shri Manmohan Vaidya & Shri A. Jayakumar at Vijnana Bharati National Convention, Nagpur, July, 2014

Awards

2014
Doctor of Science
Edinburgh University,UK
2012
Doctor of Laws (Honoris Causa)
Simon Fraser University
2011
IEEE Honorary Membership
IEEE
2010
Doctor of Engineering
University of Waterloo
2009
Honorary Doctorate
Oakland University
2009
Hoover Medal
ASME Foundation, USA
2009
International von Kármán Wings Award
California Institute of Technology, USA
2008
Doctor of Engineering (Honoris Causa)
Nanyang Technological University, Singapore
2007
King Charles II Medal
Royal Society, UK
2007
Honorary Doctorate of Science
University of Wolverhampton, UK
2000
Ramanujan Award
Alwars Research Centre, Chennai
1998
Veer Savarkar Award
Government of India
1997
Indira Gandhi Award for National Integration
Indian National Congress
1997
Bharat Ratna
Government of India
1994
Distinguished Fellow
Institute of Directors (India)
1990
Padma Vibhushan
Government of India
1981
Padma Bhushan
Government of India

The true Commander-in-Chief, nation's favourite.

President turns pilot, flies the SU-30 MKI, on 08th June, 2006
Dr. Kalam became the oldest Indian to fly a fighter aircraft after completing his 30-min ride in the rear cockpit of the aircraft.



During the 1970s, when India had hardly dreamt of its SLV, Dr. APJ Abdul Kalam launched SLV III in July 1980, which deployed Rohini in near earth orbit. It was nearly a decade's hard work of Kalam, which made this task possible.

Former Indian Prime Minister Indira Gandhi allotted secret funds to Dr. Kalam through her discretionary power for classified aerospace projects.

Toiling at Thumba -- Aravamudan and Abdul Kalam

Carrying a Sounding Rocket Nose Cone on a Bicycle Carrier at Thumba - C R Satya (right) and Kalam (Left)

Dr. Kalam was appointed as the CEO of Integrated Guided Missile Development Program. Rather than backing off from this responsibility, Kalam tried in the best way possible to make it successful. As a result of his hard work and devotion, missiles like AGNI (a ballistic missile) andPRITHVI (surface-to-surface missile) came into existence.

During his tenure as Secretary of the Defence Research and Development Organization and Chief Scientific Advisor to Prime Minister between July 1992 and December 1999, he took some great decisions. Dr. Kalam's intensive technical and political help in Pokhran-II nuclear tests earned him a lot of media coverage and established him as the best living nuclear scientist in the country.

India's first coronary stent was developed un 1998, by Dr. Kalam along with cardiologist Dr Soma Raju, in collaboration with Mediciti Hospitals, Hyderabad. Coronary stents are widely used by cardiologists to dialate constricted arteries for treating heart attacks. The main objective behind developing these stents was to substantially bring down the cost and make it affordable to the common man. The stent known as Kalam-Raju stent, underwent satisfactory clinical trials. Subsequently nearly 2000 stents were implanted in the next few years at a cost of Rs.15,000/- each as against the then market price of Rs 40-60,000 for a comparable imported stent.

Kalam was one of those scientists who aims at putting technology created by him to multiple use. He used the light weight carbon-carbon material designed for Agni to make calipers for the polio affected. This carbon-carbon composite material reduced the weight of the calipers to 400 grams (from its original weight of 4kgs.) Nizam's Institute of Medical Sciences (NIMS, Hyderabad) was the birthplace for the defence technology spin offs from Kalam's labs via the DRDL (Defence Research and Development Laboratory), DMRL (Defence Metallurgical Research Lab) and the RCI (Research Centre Imarat).

Kalam was also responsible for one project that barely gets talked about: India's first indigenous hovercraft. Project Nandi, at the Aeronautical Development Establishment, was thrust on Kalam's shoulders early on.

Dr. Kalam and Soma Raju, a well-known cardiologist, came up with a rugged tablet computer in 2012 to take care of the health of underprivileged people in rural India. It helped the government fight many health issues.

Honours & Recognitions

Kalam was the proud recipient of Padma Bhushan, Padma Vibhushan and Bharat Ratna awards from the Government of India. He received the same in the years 1981, 1990 and 1997, respectively.

In 1997, he was honored by the Government of India with the Indira Gandhi Award for National Integration.

Later, the next year, he was awarded the Veer Savarkar Award by the Government of India.

The Alwars Research Centre, Chennai, bestowed Kalam with Ramanujan Award in the year 2000.

Kalam was honored with the King Charles II Medal by the Royal Society, U.K in 2007.

The California Institute of Technology, U.S.A, presented Kalam with the International von Karman Wings Award in the year 2009. The same year, he won the Hoover Medal by ASME Foundation, USA.

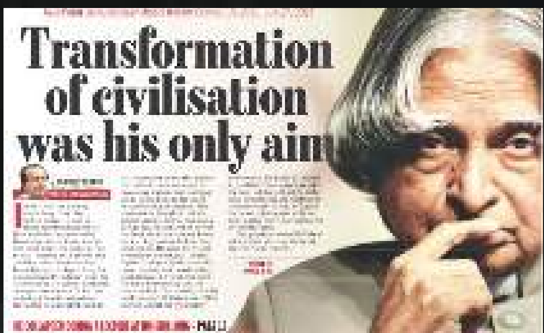
The IEEE honored Kalam with IEEE Honorary Membership in 2011.
Kalam was the proud recipient of honorary doctorates from 40 universities.

He was nominated for the MTV Youth Icon of the Year award in 2003 and in 2006.

Switzerland declared May 26 as the Science Day in honour of visiting President APJ Abdul Kalam. This was announced by the Swiss government, on May 26th 2005. Switzerland considers the Dr. Kalam as the father of India's missile programme. Kalam had visited CERN and also witnessed the signing of an agreement between the Department of Atomic Energy and the CERN.

LEGEND FOREVER..

Dr A.P.J. Kalam passed away at a private hopital in Shillong, Meghalaya, due to heart failure after having collapsed during a lecture at Indian Institute of Management, Shillong on the 27th of July 2015.


Transformation of civilisation was his only aim

Dr. Kalam passed away on the evening of 27th July 2015.

Prime Minister Narendra Modi laying a wreath near the mortal remains of former President APJ Abdul Kalam during his funeral ceremony

Dr Kalam’s elder brother and other members of his family at his funeral.

Rose petals were placed over the grave of APJ Abdul Kalam

People Came From Chennai, Pondicherry, Even USA, to Bid Dr Kalam Farewell

NAMASTE

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This booklet has been prepared by Science India Forum for utilization as internal training material for participants of Shastra Pratibha Contest 2016 MEA, conducted by Science International Forum, the international arm of Vijnana Bharati, India.

For additional clarifications or for suggesting revisons/reviews about the booklet content, please mail to SIF.

THE GREAT INDIAN SCIENCE STORY

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Sastra Prathibha Contest, 2016
Study Material - Sub Juniors